# Analysis of Enterprise Architecture Alignment: Delivering System of Systems Solutions in Response to Shifting Customer Expectations

by

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B.S. Biosystems Engineering, Oklahoma State University, 2004

Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

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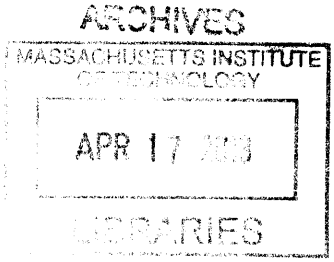


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## Abstract

There is urgency for NewCo, a large multinational corporation, to better execute programs spanning across product lines. This is because the number of these programs appears to be increasing and there are indicators that this trend will continue moving forward. The increase is driven by both business and customer needs for commonality as well as a shift in customer expectations making NewCo's current product lines a subsystem in a large system of systems. NewCo has recently struggled to execute programs implementing technology spanning product lines successfully. The organization is rooted in decentralized engineering of individual product lines and gaining alignment across these internal stakeholders is very difficult.

The goal of this research is to identify factors making programs that span across multiple product lines and corporate divisions more difficult than expected making achieving commonality difficult. The research will also recommend potential changes to the design of the overall enterprise to improve the ability to execute programs spanning multiple product lines successfully. Using an exploratory research approach, the current state of NewCo has been evaluated based on value exchange with stakeholders and an eight views enterprise architecting framework.

Nine individual factors that contribute towards the difficulty in these programs that consolidate into five categories are identified. The first category ties to strategy and includes three topics: the lack of enterprise alignment, the impact of decentralized history and culture, and the strategic choice in addressing system of systems transition. The second category relates to the organization structure and has three veins within it as well: the status of most recent organizational realignment, the perceptions around supporting businesses and shared services, and the increase in councils and committees. The third category discusses enterprise policies focusing on the metrics used to measure the divisions. The fourth category reviews the decision making process and the culture of consensus. The fifth and final category relates to knowledge sharing and recent process improvements and shifting roles that impact the ability to effectively share knowledge.

Six initial recommendations are presented based upon the findings of this research. First, intentionally "design" the system of systems solution including centralizing a portion of engineering to allocate requirements to product lines and shared services. Second, reinvigorate reorganization effort of Division B and expand shared services. Third, revise policies to incent cooperation and supporting system of systems solutions. Fourth, establish clear roles and empower decision makers. Fifth, continue to invest in process improvements within the marketing organization and the knowledge transfer into product development. The sixth and final recommendation includes reiterating that programs spanning product lines are difficult. This would create awareness that commonality and system of systems solutions are not easy to develop. If team members and leadership begin these programs acknowledging the challenges ahead of them they will be better able to position the program for success.

The next step is to validate these recommendations with senior leaders within NewCo. Additional research could continue though the Enterprise Strategic Analysis and Transformation (ESAT) framework and complete steps five through eight for NewCo. A second future research opportunity would be to conduct a larger study incorporating different enterprises within different industries that are facing the same challenge of shifting from individual product lines to delivering customers complete integrated solutions that span traditional product boundaries. This type of research could potentially identify best practices and provide insights for the most effective enterprise architecture.

Thesis Supervisor: Dr. Donna H. Rhodes
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# TABLE OF CONTENTS


Introduction ..... 13

1.1 NewCo ..... 14

1.2 Division A ..... 15

1.3 Problem Definition ..... 16

1.4 Motivation ..... 17

1.5 Research Questions ..... 18

1.6 Organization of Thesis ..... 18

Literature Review ..... 21

2.1 Commonality and Platforms ..... 21

2.2 System of Systems ..... 24

2.3 Viewing Enterprises as Systems ..... 27

2.4 Seven Principles of Enterprise Thinking ..... 28

2.5 Enterprise Strategic Analysis And Transformation ..... 30

2.6 Enterprise Systems Architecting ..... 31

Research Approach ..... 35

3.1 Case Study Selection ..... 36

3.2 Interview Design ..... 37

3.3 Interview Candidates ..... 37

3.4 Data Collection ..... 38

3.5 Data Analysis ..... 39

Case Studies ..... 43

4.1 Program A ..... 44

4.2 Program B ..... 45
4.3 Program C ..... 47
Stakeholder Analysis ..... 49
5.1 Employees ..... 50
5.2 NewCo Leadership ..... 51
5.3 Shareholders ..... 51
5.4 Customers and Distribution Channel ..... 51
5.5 External Partners ..... 51
5.6 Internal Partners ..... 52
5.7 Stakeholder Prioritization ..... 55
Current State Evaluation ..... 59
6.1 Products and Services ..... 60
6.2 Strategy ..... 61
6.3 Policy ..... 64
6.4 Organization ..... 70
6.5 Knowledge ..... 71
6.6 Process ..... 72
6.7 Information Technology ..... 74
Conclusions ..... 75
7.1 Key Findings ..... 76
7.2 Recommendations ..... 79
7.3 Areas for Further Investigation ..... 81
Appendix A: Interview Template ..... 83
Appendix B: Interview Protocol ..... 87

Appendix C: Interview Analysis ..... 89

References ..... 95

# LIST OF FIGURES

Figure 1. Tradeoff between Distinctiveness and Commonality (Robertson and Ulrich 1998)22

Figure 2. System of Systems ..... 25

Figure 3. Value –Creation Framework (Murman, Allen et al. 2002) ..... 29

Figure 4. Enterprise Strategic Analysis and Framework (Nightingale 2009) ..... 31

Figure 5. Enterprise Systems Architecting Framework (Nightingale and Rhodes 2011) ..... 32

Figure 6. Top Ten Key Topics Identified in Interviews ..... 40

Figure 7. Internal Stakeholders Involved in each Case Study ..... 44

Figure 8. Stakeholders of Division A ..... 50

Figure 9. Internal Partners that Interact with Division A ..... 52

Figure 10. Venn Diagram of Stakeholder Saliency ..... 56

Figure 11. Stakeholder Topology (Mitchell, Agle et al. 1997) ..... 57

Figure 12. Eight Views Framework ..... 60

Figure 13. Tier Definitions for Research, Development, and Engineering (Hauser 1998) ..... 68

# LIST OF TABLES

Table 1. Characteristics of System of Systems (Maier 1998) ..... 26

Table 2. Seven Principles of Enterprise Thinking (Nightingale 2009) ..... 28

Table 3. Enterprise Systems Architecting Views (Rhodes, Ross et al. 2009) ..... 33

Table 4. Distribution of Interviewees Across Case Study Programs and Dimensions ..... 38

Table 5. Seven Pitfalls of Counterproductive Metrics (Hauser and Katz 1998) ..... 69

Table 6. Seven Step System to Define Good Metrics (Hauser and Katz 1998) ..... 70

Table 7. Guidelines for Designing Decision Units and Decision Management Systems (Huber and McDaniel 1986) ..... 74

Table 8. Summary of Key Findings ..... 76

Table 9. Summary of Recommendations ..... 79

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# Chapter 1

## INTRODUCTION

An organization rooted in decentralized engineering of individual product lines has recently struggled to execute programs implementing technology spanning product lines successfully. Requirements definition is an extended phase where a lack of compromise between design teams leads to a final subsystem that no one is fully satisfied with. Gaining alignment across stakeholders is the primary difficulty faced by these programs. Additional difficulty occurs when these programs do not follow the best case scenario that was planned for with stakeholders and contingency plans are needed.

The goal of this research is to identify factors making programs that span across multiple product lines and corporate divisions more difficult than expected. As a result of the research, recommendations will be made for potential changes to the design of the overall enterprise to improve the ability to execute programs spanning multiple product

lines successfully. The remainder of this section introduces the enterprise being investigated, further defines the problem statement and motivation, identifies the research questions to be answered, and finally discusses the organization of this thesis.

## 1.1 NEWCO

NewCo[1] is a large multinational corporation. For the purposes of this thesis, the research will focus on a single division, referred to as Division A. The internal divisions with which Division A interacts heavily will also be discussed as needed. NewCo was historically constructed of many acquisitions that have remained fairly decentralized and report under a single financial umbrella. Each division is focused on a particular product line, set of related product lines, or a critical subsystem. The subsystems are also sold as original equipment to other manufacturers (OEM). NewCo is rooted in a conservative culture and has developed new leaders within the company.

NewCo's acquisitions in most cases remained in their existing facilities resulting in a many geographically distributed locations across North America and Europe. Recent global growth has increased the geographic distribution into South America, Asia, and parts of Africa. Within each division and product line there are in most cases multiple worldwide locations represented.

NewCo has been reorganized many times throughout history as the product lines have evolved. However, NewCo has fundamentally believed in the strength of maintaining decentralization and allowing each product line to focus on their segment and optimize their products. Due to the multiple geographic locations this has in some cases resulted in divergent designs within the same product line to support what is perceived as unique

[1] NewCo is a fictitious name of a real company that has been used throughout this thesis.

needs for each region of the world. The financial reporting structure has reinforced this local optimization and encouraged the development of, what many would argue are, the best products in the industry.

## 1.2 Division A

Division A is a supporting business within NewCo. It began as a research and development group within Product Line DD in the 1990's. Division A began as a small team focused on new applications of technology to provide additional value to the customer. The subsystems the team designed and developed were sold as aftermarket products that could be added onto vehicles.

In 2001 the group had gained enough customer acceptance and profitability to be formed into its own separate division. The Division began to aggressively grow from approximately 30 members to over 500 employees today. The growth was spurred by widespread market acceptance of a few core products. These products were integrated into the vehicle product lines of Division B as factory installed subsystems and are now considered part of the base equipment on many vehicles today. Division A spends a portion of its resources, both time and money, continuing to work on aftermarket products as well as filling requests from product lines to support current subsystems on new generations of vehicles as well as developing entirely new subsystems to address emerging customer needs.

Division A is primarily focused on software development and combined with the recent growth has a much different demographic and culture than the other NewCo divisions. Division A operates in a manner to compete with other major software companies with a casual dress code, flexible work schedules, and team empowerment. The other NewCo divisions are more closely tied to manufacturing and have a more traditional work

environment with business casual dress and more restrictive policies. The workforce at Division A is also much younger due to the recent growth and places a stronger emphasis on work-life balance. Division A employees also typically have a much broader perspective having had the opportunity to work across the many product lines and in many regions of the world.

## 1.3 Problem Definition

Two recent programs at NewCo were given the task of developing technology and subsystems to be leveraged across multiple product lines. Both programs successfully launched the subsystems into production, but each program required more effort than expected and created unexpected tension within the organization. Both of the programs had many similarities as well as differences leading many within NewCo and Division A to wonder what contributed towards the perceived difficulty. A third program has begun that also bridges multiple product lines and again the initial phases of the design process have been more difficult than expected with many internal stakeholders not fully satisfied.

The number of programs that span multiple product lines appears to be increasing and there are indicators that this trend will continue moving forward. The increase is driven by both business and customer needs for commonality. The business needs to spread research and development investments across a larger number of products. The customer has a desire to have a common look and feel between product lines. There is significant literature on the benefits of commonality and developing platforms. This research will focus on why achieving commonality is so difficult. The research will also focus on improvements to the enterprise design that may enable achieving commonality more easily.

## 1.4 Motivation

There is urgency for NewCo to better execute this type of program due to the current external environment the enterprise is working within. Bartolomei et al. (2012) discusses how "the scope and complexity of engineered systems are ever-increasing as burgeoning global markets, unprecedented technological capabilities, rising consumer expectations, and ever-changing social requirements present difficult design challenges." Schulz et al.(2000) identified three key factors impacting companies: a dynamic marketplace, technological evolution, and variety of environments. New markets are opening rapidly and existing markets are changing driving for more responsiveness and faster speed to market. Technological evolution affects systems incorporating a high percentage of system functionality based in electronics and software because of the much shorter half-life of these technologies. Today's systems are frequently being embedded into a system of systems and are affected by the changes of their own subsystems as well as the systems they interact with.

With these external factors NewCo is currently sitting at a precept of monumental change. NewCo's current product lines are becoming a subsystem in a large system of systems. Many companies fail to recognize the transition in customer needs and continue to optimize their current product lines. This prevents the company from delivering a new type value to their customers and capitalizing on an entirely new market. It is often difficult for companies to see the next opportunity and not become complacent due to the success of the products they currently provide.

NewCo has successfully made a similar transition in the 1920's. NewCo branched into a new technology that dramatically impacted the role of their then current product line. Company memos indicate that the transition was difficult and doubted by many at the time.

However in hindsight the shift in product focus has proven to have been a major factor in the continued success of NewCo.

A similar trend can be seen in many industries ranging from defense, with the networked soldier, to media, with Apple's suite of integrated solutions. This shift is moving the products previously thought of as the system being designed to a part of the overall system of systems.

## 1.5 Research Questions

The goal of this research is to identify factors making programs that span across multiple product lines and corporate divisions more difficult than expected. The research will also recommend potential changes to the design of the overall enterprise to improve the ability to execute programs spanning multiple product lines successfully. In context of these types of programs, two research questions will be addressed:

- What are the critical forces driving design decisions as well as barriers to effective decision making?
- What transformation strategies could allow more success in implementing shared components or platforms across product lines?

## 1.6 Organization of Thesis

This thesis is organized into the following chapters:

1. Introduction: This section introduces the enterprise, defined the problem statement and motivation, and identifies the research questions to be answered.
2. Literature Review: This section discusses the current literature on commonality and platforms, systems of systems, organizational dynamics,

enterprise strategic analysis and transformation, and an enterprise architecting framework.

3. Research Approach: This section explains the method of data collection and data analysis.
4. Case Studies: This section provides context for each case study program.
5. Stakeholder Analysis: This section identifies and discusses the stakeholder groups that contribute to the new product development value chain within Division A.
6. Current State Evaluation: This section evaluates the current state of NewCo and Division A using the Eight Views Framework.
7. Conclusion: This section summarizes the key findings, presents recommendations, and identifies areas for further research.

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# Chapter 2

# LITERATURE REVIEW

A literature review was conducted to gather insight into effective platform approaches and methods to evaluate an enterprise. The content of this section will discuss the current literature on commonality and platforms, systems of systems, organizational dynamics, enterprise strategic analysis and transformation, and an enterprise architecting framework.

## 2.1 COMMONALITY AND PLATFORMS

A platform is defined as "a collection of assets that are shared by a set of products"(Robertson and Ulrich 1998). Components, processes, knowledge, and people and relationships create four categories of assets that can be shared.

Platforms can create benefits in many areas for a company. Platforms can reduce manufacturing costs due to the increase volumes and the benefits of economies of scale. Platforms can also reduce development costs and time by leveraging the initial investment. Platforms can also reduce the risk by requiring a lower investment for each new product (Robertson and Ulrich 1998).

Creating platforms also has challenges. Primarily balancing the distinctness desired by various market segments with the desire for commonality and shared components. The product architecture can determine the tradeoffs that are available between these as shown in Figure 1. Desai et al. (2001) concluded that design, marketing, and manufacturing were all required to collaborate to ensure the best decisions regarding the profitability of commonality.

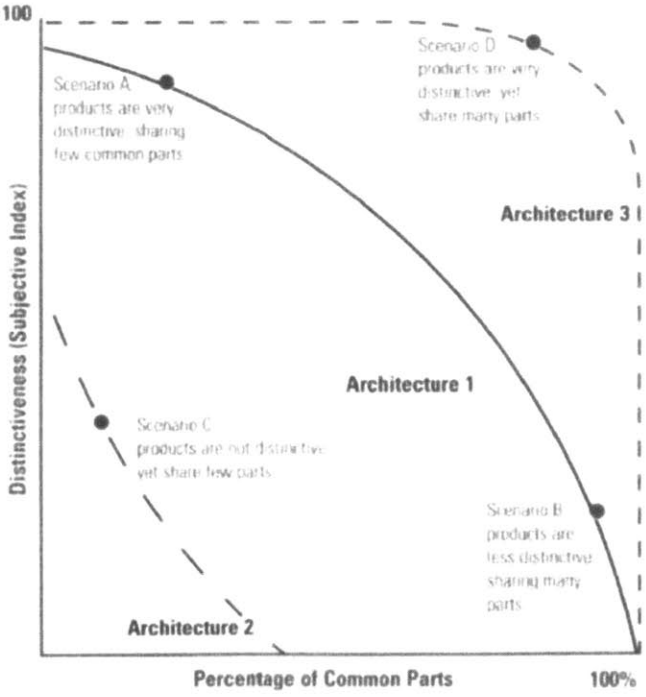


***Figure 1. Tradeoff between Distinctiveness and Commonality (Robertson and Ulrich 1998)***

An additional challenge in creating platforms discussed by Krishnan and Gupta (2001) is balancing the benefits of integration with the overdesign of the lower end products within the product family. Their model went further to identify that the rewards and incentive systems used with design teams needed to focus on their overall impact to the product family. Often teams are rewarded based upon the time and money associated with an individual program. If this system is used there is no incentive to invest in platforms.

Halman et al. (2003) believe that a product family should be built understanding market segments, branding, global supply and distribution, and the processes within the value stream in addition to the traditional discussion of product architecture. Their research supports the claim with cases from different companies that utilized different combinations of the aforementioned assets as well as the product architecture. The companies involved in the study noted that it was difficult to understand and manage the risks associated with designing platforms and there was "a lack of practical guidelines and decision rules."

Fisher, Ramdas, and Ulrich (1999) identified three drivers of component sharing: cost, product quality and performance, and organizational structure. Cost includes investment in new products, the variable cost of production, and what Fisher et al. deemed the system costs: production, distribution, and after-sale support. The system costs are largely driven by the number of unique parts. The product quality and performance are also affected by commonality as the shared components must be designed and tested to withstand the most intensive application. The organizational structure can also affect the ability to share components. Integrated product teams create a more agile and responsive environment to shifting market needs than a functionally aligned organization, but the autonomy makes component sharing across product teams very difficult to coordinate.

Meyer and Mugge (2001) emphasize that in order for major subsystems to be shared and reused between separate business units of a company the subsystems themselves must be considered a strategic platform. They suggest a method of having each business unit define platform architectures independently and then meet to review as a group and determine what can be shared or co-developed. They also recommend reviewing past successful platforms to understand the research and development involved, cycle time, and revenue generated. A detailed case at IBM demonstrates how the organization, culture, and incentives can prevent effective use of common components. The authors suggest platform subsystem groups that function as centers of excellence in developing subsystems with superior performance, scalability, and a cost advantage. These subsystems can then be leveraged by applied engineering teams within the different business units.

## 2.2 System of Systems

INCOSE (2007) defines a system as "a combination of interacting elements organized to achieve one or more stated purposes." They define a system of systems as "a system-of-interest whose system elements are themselves systems; typically these entail large scale inter-disciplinary problems with multiple, heterogeneous, distributed systems." A graphical representation of system of systems is depicted in Figure 2.

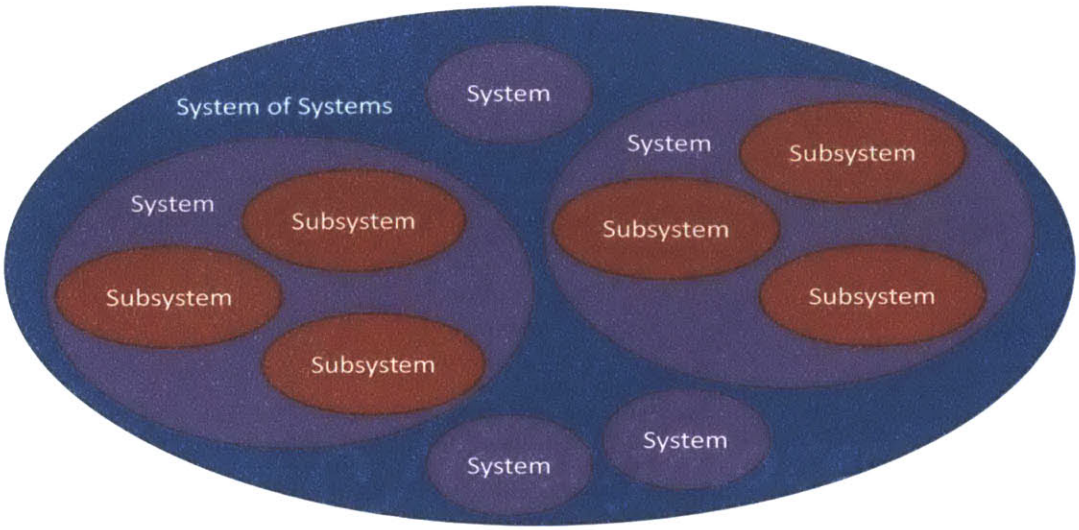


*Figure 2. System of Systems*

Maier (1998) clarifies that system of systems should be separated from large, complex, monolithic systems by evaluating five characteristics, shown in Table 1. Systems of systems require additional attention to interface design. This is because communication standards are often the only means an architect has to share the intent of the system of systems. These interactions between components are what create the emergent behaviors that in turn create the value of the system of systems.

*Table 1. Characteristics of System of Systems (Maier 1998)*

| Characteristics | Description |
|---|---|
| **Operational Independence of the Elements** | If the system-of-systems is disassembled into its component systems the component systems must be able to usefully operate independently. The system-of-systems is composed of systems which are independent and useful in their own right. |
| **Managerial Independence of the Elements** | The component systems not only can operate independently, they do operate independently. The component systems are separately acquired and integrated but maintain a continuing operations existence independent of the system-of-systems. |
| **Evolutionary Development** | The system-of-systems does not appear fully formed. Its development and existence is evolutionary with functions and purposes added, removed, and modified with experience. |
| **Emergent Behavior** | The system performs functions and carries out purposes that do not reside in the component systems. These behaviors are emergent properties of the entire system-of-systems and cannot be localized to any component system. The principal purposes of systems of systems are fulfilled by these behaviors. |
| **Geographical Distribution** | The geographic extent of the component systems is large. Large is a nebulous and relative concept as communication capabilities increase, but at a minimum it means that the components can readily exchange only information and not substantial quantities of mass or energy. |

Shah et al. (2007) discuss how understanding the context in which a system of systems will operate can be difficult, but is key to system success. They go on to discuss that centralized coordination may be the best method to manage the integration.

Carlock and Fenton (2001) indicate that a stand-alone system typically engineered and developed within a constrained budget, schedule, and requirements baseline. A stand-alone system while technically complex is usually deployed as a whole at the same time. They also mention that characteristics are prioritized based on technical performance, then operational performance, then economic performance, and finally political. Carlock and

Fenton then go on to contrast the stand-alone system with a system of systems. The system of systems is usually far more complex. This is because each system must be developed and working on its own as well as being integrated and working effectively together. Another key difference is that systems of systems continually evolve deploying new systems within them with no defined end state. A system of system also often prioritizes differently with interoperability as the primary focus followed by acceptable performance at an acceptable cost. This rearranges the characteristics to a priority order of political, economic, operational and lastly technical performance. Their final point is that traditional systems engineering processes do not work well with systems of systems. The processes must be extended to account for the expanded requirements. They propose a three tiered framework to aid with systems of systems.

## 2.3 Viewing Enterprises as Systems

Multiple authors have discussed how an organization or enterprise is in itself a system. However, enterprises are rarely considered systems themselves. Often the individual functions or projects are independently optimized. This lack of consideration for the interactions across the enterprise limits the ability to achieve the greatest benefit to the stakeholders (Rouse 2005).

Ackoff (1971) said "an organization is a purposeful system that contains at least two purposeful elements which have a common purpose relative to which the system has a functional division of labor; its functionally distinct subsets can respond to each other's behavior through observation and communication; and at least one subset has a system-control function." Rouse (2001) indicated "an enterprise is a goal-directed organization of resources – human, information, financial, and physical – and activities, usually of significant operational scope, complication, risk, and duration."

In *Systems Architecting of Organizations*, Rechtin (2000) establishes four premises. First, reiterating Rouses point, organizations are complex people based systems. Second, "every system and organization has architecture, or 'structure' broadly defined which determines what the system can and can't do." Third, systems architecting can be applied to organizations just as it is applied to engineered products. Fourth, "systems architectural insights and techniques, heuristics and metaphors in particular, can be effectively used to sustain the excellence during times of global competition and unavoidable change."

## 2.4 Seven Principles of Enterprise Thinking

Nightingale (2009) identified seven principles of enterprise thinking shown in Table 2. The principles provide guidelines when working to sustainably transform an enterprise.

***Table 2. Seven Principles of Enterprise Thinking (Nightingale 2009)***

| | |
|---|---|
| **1** | Adopt a Holistic Approach to Enterprise Transformation |
| **2** | Identify Relevant Stakeholders and Determine their Value Propositions |
| **3** | Focus on Enterprise Effectiveness before Efficiency |
| **4** | Address Internal and External Enterprise Interdependencies |
| **5** | Ensure Stability and Flow within and across the Enterprise |
| **6** | Cultivate Leadership to Support and Drive Enterprise Behaviors |
| **7** | Emphasize Organizational Learning |

The first principle discusses a holistic approach to enterprise transformation. Often enterprise transformations are done within silos without considering the enterprise as a whole. *Lean Enterprise Value* (Murman, Allen et al. 2002) described the practice of tackling "low hanging fruit" - visible, easy to solve opportunities - as creating "islands of success." Each improvement may be a success, but it may be relatively isolated and not be a critical when considering the enterprise as a whole. The larger challenge is to work on issues in an integrated way to satisfy the needs of all the stakeholders involved.

The second principle recognizes that enterprises have multiple stakeholders. Murman et al. (2002) proposed a three phase value-creation framework shown in Figure 3. The third stage, value delivery, is most often discussed in lean literature and value stream mapping. This is where value is delivered to each stakeholder involved in the process. Murman et al. (2002) suggests that inadequate effort is placed upon the first two phases to ensure the enterprise is delivering the right value. The first phase involves finding the stakeholder value, identifying the stakeholders and what each values or needs. The second stage, value proposition, involves aligning the stakeholders with the enterprise value streams and balancing the expectations of each. The third phase then executes on the promises made. An approach for value exchange is developed and then agreed to. The three phase model develops a holistic view of the value stream for the enterprise.

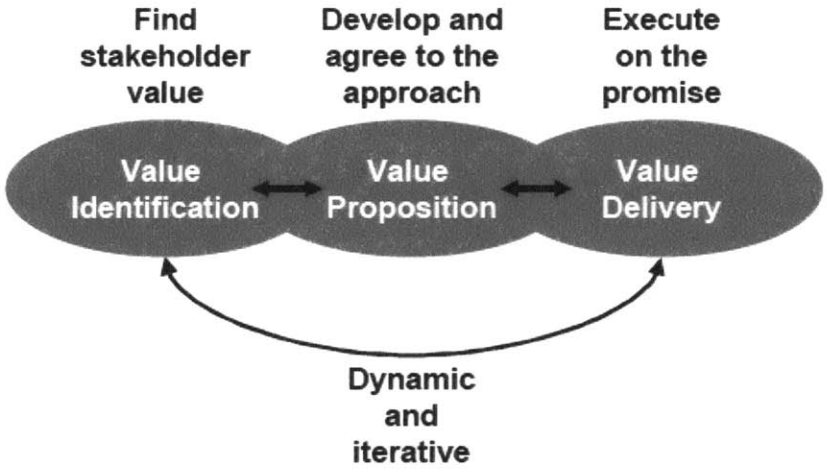


*Figure 3. Value –Creation Framework (Murman, Allen et al. 2002)*

The third principle discusses the importance of "doing the right thing" first then working on "doing it right"; effectiveness before efficiency. Efficiency measurements typically apply to processes and do not measure if the process is delivering the needed

value in the first place. An understanding of the enterprise strategy and the value proposition are needed to be successful.

The fourth principle, address internal and external enterprise interdependencies, emphasizes the importance of interfaces and the definition of the boundary or scope of the enterprise.

Ensure stability and flow, the fifth principle, highlights the importance of having a stable baseline from which the current state can be investigated and improvement opportunities identified. Understanding the flow of information within an enterprise is key to executing value delivery.

The sixth principle discusses the importance of leadership support to drive enterprise transformations. Middle management was highlighted as a key. They translate the strategic framework provided by senior leadership to the rest of the organization (Nightingale 2009).

The seventh and final principle, emphasize organizational learning, allows the transformation efforts to be improved and enhanced by sharing lessons learned from each area of the organization with others to benefit the overall success of the transformation effort.

## 2.5 Enterprise Strategic Analysis And Transformation

Enterprise Strategic Analysis and Transformation (ESAT) is a framework developed by the Lean Advancement Initiative at Massachusetts Institute of Technology, shown in Figure 4, which provides a holistic approach to evaluating the performance of the enterprise (Nightingale 2009). ESAT differs from many other frameworks in that it focuses at the overall enterprise level and identifies opportunities for improvement that will in turn benefit the entire enterprise. Steps one and two define the enterprise, gather the

stakeholders involved, and identify the key processes and metrics. Steps three and four analyze the current state of the enterprise and identify opportunities and wastes. Step five develops a future state vision while steps six, seven, and eight develop a transformation plan to achieve the future state.

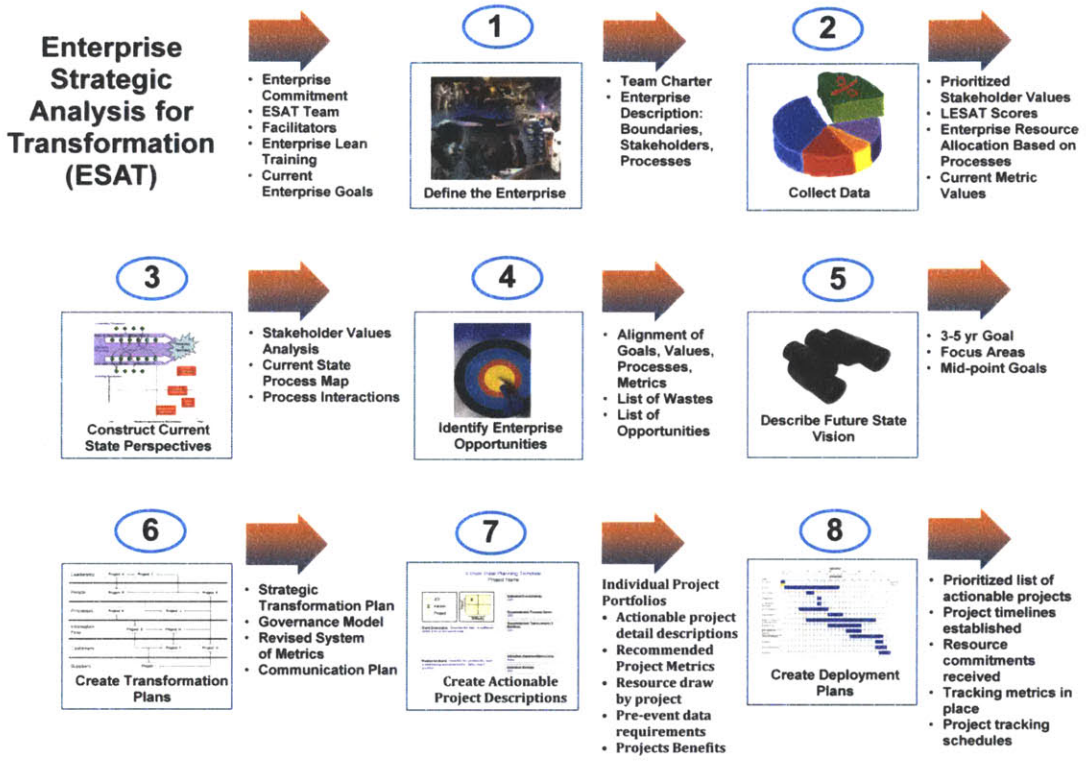


*Figure 4. Enterprise Strategic Analysis and Framework (Nightingale 2009)*

## 2.6 Enterprise Systems Architecting

The current field of Enterprise Architecting has created many frameworks including the Zachman Framework for Enterprise Architecture, Department of Defense Architecture Framework (DoDAF), Federal Enterprise Architecture Framework (FEAF), Treasury Enterprise Architecture Framework (TEAF), and The Open Group Architectural Framework (TOGAF)(Urbaczewski and Mrdalj 2006). Each of these frameworks focuses on information

technology and does not take an adequately holistic view of the enterprise. As the product and services provided by enterprises grow in complexity, so too does the enterprise itself. This growth in complexity lends itself to a more robust evaluation incorporating additional perspectives into the assessment. To address this Nightingale and Rhodes (2004) have proposed Enterprise Systems Architecting as an emerging field within Engineering Systems. They define Enterprise Systems Architecting as "a new strategic approach which takes a systems perspective, viewing the entire enterprise as a holistic system encompassing multiple views ... in an integrated framework" (Nightingale and Rhodes 2004).

Nightingale and Rhodes (2011) identified eight views or lenses as being critical to developing a holistic view of the enterprise. These views are interconnected as shown in Figure 5 with the solid lines depicting primary relationships and dotted lines representing secondary relationships.

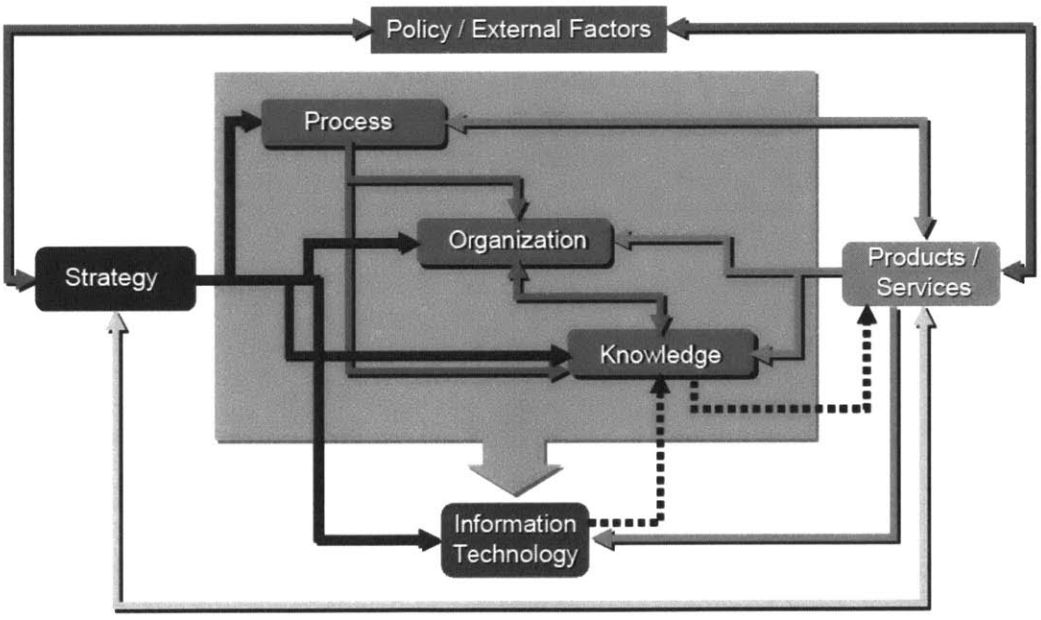


*Figure 5. Enterprise Systems Architecting Framework (Nightingale and Rhodes 2011)*

Products/services and strategy are the primary views that heavily influence the competency of the enterprise: process, organization, and knowledge. Policy and external factors affect both the strategy and the products and services. Information technology is an enabler that is based upon the needs of the other views. Table 3 provides a summary of each view.

*Table 3. Enterprise Systems Architecting Views (Rhodes, Ross et al. 2009)*

| View | Description |
|---|---|
| **Product** | Products produced by the enterprise for use by its stakeholders. |
| **Services** | Services of the enterprise, including services as a primary objective or in support of product. |
| **Strategy** | Goals, vision, and direction of the enterprise, including business model and competitive environment. |
| **Policy** | External regulatory, political, and societal environments in which the enterprise operates. |
| **Organization** | Organizational structure as well as relationships, culture, behaviors, and boundaries between individuals, teams, and organizations. |
| **Process** | Core processes by which the enterprise creates value for the stakeholders. |
| **Knowledge** | Implicit and tacit knowledge, capabilities, and intellectual property resident in the enterprise. |
| **Information** | Information needs of the enterprise, including flows of information and systems/technologies for information availability. |

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# Chapter 3

## Research Approach

This research focuses on three recent programs as case studies. The research analyzes the programs to understand why achieving commonality is so difficult. The research will also analyze the programs to determine critical forces driving design decisions as well as barriers to effective decision making. The technical and financial details have been removed to protect the program and company anonymity. Interviews with program team members and a review of program artifacts were utilized to gather data relevant to each case. This section will explain the method of data collection and data analysis used to investigate the current state of the enterprise.

Traditional deductive research would begin with a hypothesis, but inductive research begins with an interesting area or question. This flexibility and open-mindedness in approach is useful in situations where not enough known initially to create a testable

hypothesis. (Stebbins 2001) This research uses an exploratory or inductive approach to document the current state of an enterprise. Typically exploratory research works to develop a grounded theory, but in this research the observations will be evaluated to recommend potential improvements in the design of the enterprise.

## 3.1 Case Study Selection

The intent of the case studies was to utilize programs to create a timeframe and context that the enterprise could be assessed within. The case studies represent a trend in programs to include more and more internal stakeholders as common infrastructure components are design to be leveraged as a platform across multiple product lines as mentioned in the motivation section. The case studies were selected due to key similarities as well as differences.

The similarities between the programs selected included each being led by Division A and involving multiple internal stakeholders. Each program worked to develop a common electronic component, which would then be utilized by multiple product lines. The programs included development of both the hardware and application software. In Program B the development of a web interface and backend database was also included.

The differences include the timeframe of each program which led to different knowledge on how to manage the many internal stakeholders at the time of each program. Program A chartered in May of 2007 and was launched to customer 24 months later. Program B chartered in September of 2008 and launched 28 months later. Program C chartered in December of 2009 and has yet to launch. Each succeeding program leveraged lessons learned documented from the earlier programs and in many cases involved the same key stakeholders.

## 3.2 Interview Design

The interview consisted of two sections. This first portion included nine background questions to benchmark the interviewees experience and establish their perspective of each of the case programs they were involved in. A brief overview of the eight views framework was then presented and the second section of questions was asked. The second portion consisted of thirteen questions related to the views, one question regarding the characteristics or -ilities they valued in a program, and two questions gathering their concepts for an ideal program. The interview format was semi structured allowing for open ended responses and references to examples from the programs. Appendix A includes the interview template.

## 3.3 Interview Candidates

Each interview candidate was knowledgeable about one or more of the three programs identified as case studies. Candidates were selected to ensure that diverse perspectives would be represented within the sample. The following three dimensions were considered for each candidate and also utilized when evaluating the data:

1. Balanced input from members of the shared services divisions as well as the product line divisions.
2. Balanced input from members on the execution team and each division's leadership.
3. Balanced input from those with engineering and program management roles.

Table 4 shows the breakdown of interviewees along these dimensions. A total of 38 individuals were interviewed. The engineering organization represented 24 of the 48 interviewees with program management representing the remaining 14. Members of the

product development teams that executed each program made up 22 of the interviewees. Members of leadership included managers from engineering and program management functional areas as well as the director of Division A and the vice president of Engineering Services. Division A represented the largest portion of the interviewees, 21 of the 48, due to the high degree of involvement leading the programs. Representation from Division E and Product Line AA constituted 6 and 7 interviewees respectively. The remaining two groups, Product Line DD and Division C, each had two interviewees, one from leadership and one from the execution team.

*Table 4. Distribution of Interviewees Across Case Study Programs and Dimensions*

| | Program A | Program B | Program C | Total |
|---|---|---|---|---|
| **Total Interviewees** | 20 | 26 | 17 | 38 |
| **Engineering** | 13 | 16 | 10 | 24 |
| **Program Management** | 7 | 10 | 7 | 14 |
| **Leadership** | 12 | 14 | 10 | 16 |
| **Execution** | 8 | 12 | 7 | 22 |
| **Division A** | 11 | 14 | 9 | 21 |
| **Division E** | 2 | 4 | 4 | 6 |
| **Product Line AA** | 5 | 5 | 4 | 7 |
| **Product Line DD** | 2 | 1 | 0 | 2 |
| **Division C** | 0 | 2 | 0 | 2 |

## 3.4 Data Collection

The interviews were conducted both onsite and virtually based upon the location of the interviewee. All interviewees were provided introductory material ahead of the scheduled appointment which included background regarding the purpose of the meeting and the first section of questions. Each interview took between 30 and 60 minutes to complete based upon the number of case study programs the interviewee had exposure to.

In a few cases time expired before the complete list of interview questions could be covered. An interview protocol was followed to ensure consistency between the interviews. This protocol is included in Appendix B. The interviews were recorded with permission allowing hand written notes to be converted into transcripts with key points identified. The interview summaries were then shared with each interviewee and approved to ensure correct interpretation of the responses.

Full access was granted to artifacts from the product design process for each case program. These artifacts were used to substantiate information learned in interviews and provide additional context.

## 3.5 Data Analysis

The interviews were reviewed and key points were identified from each. A total of 42 key topics were found with many shared across multiple interviewees. The analyzed data is presented in Appendix C. The most common topic was identified by 69% of interviewees while twenty-one of the topics were identified by four or fewer interviewees. The top ten topics are presented in Figure 6.


***Figure 6. Top Ten Key Topics Identified in Interviews***

The topics were analyzed by the frequency of occurrence along the dimensions identified above in Table 4. All responses were normalized and reported in percentages to account for the varying populations of each category. This analysis identified differences based upon the dimensions of each interviewee and influenced the stakeholder analysis and current state information presented in later sections.

The top two topics identified - difficulty aligning around a vision or strategy, lack of overall priority, lack of clear common goals and difficulty establishing common expectations - were both consistently identified across all of the dimensions without any significant differences. Lack of established decisions rights was indicated by 71% of program managers while only 38% of engineers. Different strategies between hardware and software were not

mentioned by any of the interviewees from Division E while 61% of Division A and 45% of the remaining product line interviewees did mention the differences. Poor knowledge transfer was differentiated on two dimensions, 50% of leadership versus 26% of the execution team members and 48% of engineering versus 21% of program management. Difficulty gathering and understanding customer needs was consistent across the dimensions. Forty four percent of interviewees from Division A identified slow decision making due to a culture of consensus and lack of hierarchy while on 12% of other interviewees did. Supplier versus partner relationship between internal divisions was identified by 38% of engineering versus 14% of program management and 37% of execution versus 19% of leadership. Fifty percent of leadership discussed a desire for commonality where possible, while only 11% of execution discussed commonality. There was no significant differentiation between dimensions regarding platform stakeholders often having conflicting requirements.

The pace of technology in electronics being mismatched with the vehicles was mentioned by 38% of leadership and 11% of execution. Transparency in communications was mentioned consistently across dimensions. Product line metric driving behavior and focus at a local level were mentioned by 33% of engineers and no program managers. Thirty-one percent of leadership identified a shift in the perception of the subsystems or aftermarket products developed by Division A from add-on to an integral part of the vehicle. Thirty-one percent of leadership also identified that R&D cost distributions drive behavior and focus at a local level. Only 5% of execution identified either of these topics. Customer expectations changing quickly due to consumer products was discussed by 24% of engineering and 7% of program management. The following four topics were not differentiated along any of the dimensions: 1) differences in risk tolerance between internal

stakeholders, 2) difficulty gaining engagement of internal stakeholders at program initiation, 3) enterprise product development process defines outcomes and each organization has a local implementation of actual process, and 4) internal stakeholders saying the same thing, but intending different meanings or vice versa. Fixed schedules compromising the integrity of the product was mentioned by 19% of engineering, 7% of program management, 21% of execution, 6% of leadership, and was only discussed by interviewees from Division A.

# Chapter 4

## Case Studies

A key factor in each case study was the number of internal stakeholders involved. Below in Figure 7 you will find a simplified organizational structure of NewCo. Each portion of the organization is broadly categorized as a primary product line (purple), supporting business (black), or shared service (blue). Additional information regarding the importance of these stakeholder classifications will be discussed in the stakeholder analysis section. The internal stakeholders involved in each program are identified with a red circle. The internal stakeholder identified with an orange circle for Program B in hindsight may have needed to be more heavily involved. The following sections provide a brief description of each program used as a case study to provide context for later discussion.

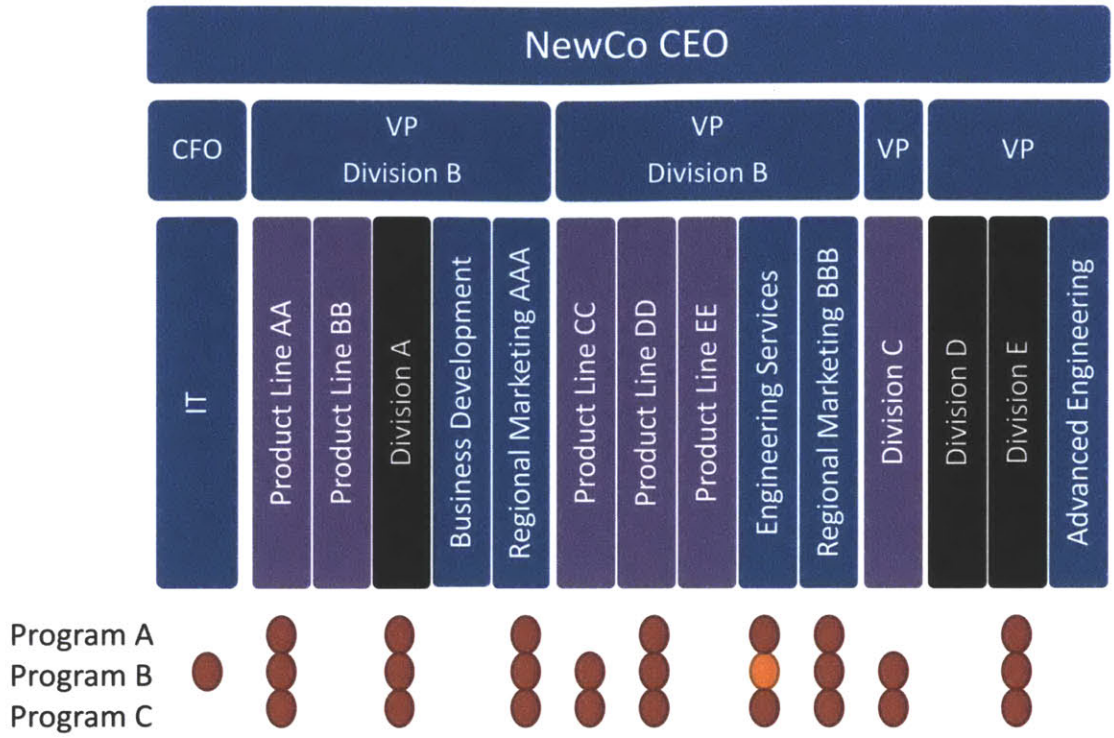


***Figure 7. Internal Stakeholders Involved in each Case Study***

## 4.1 Program A

Product Line AA was working to integrate an interactive display into the vehicle to improve setup and monitoring of vehicle operations. The engineering group within AA had proceeded with a black and white display leveraging an existing supplier, however, early customer feedback indicated that a color display was needed. If Product Line AA began development of a color display instead of the black and white at this point the entire vehicle program would be delayed.

In parallel Division A had been working to design a color display to be installed aftermarket into a variety of vehicles to support enhanced machine operations. Product Line AA approached Division A to leverage their development effort. This option

would prevent a delay to the vehicle program and allow for a color display to meet the customer need.

Program A was never formally chartered, but considered additional scope to the ongoing color display program with the added requirement to integrate the aftermarket color display into the vehicle. The effort required integrating the display into the vehicle and the exact timeline of the vehicle program were not clarified. This lack of clear expectations lead to a tense relationship where Division A felt as though they were doing a favor allowing Product Line AA to leverage the work they had already completed while Product Line AA felt that their needs were not being met and that the integrated vehicle display was more critical to NewCo than the aftermarket display program.

Program A was executed using a waterfall development process with planned hardware builds and software handoffs. The initial estimates proved to be inaccurate and technical issues discovered late in the program resulted in a major package of features being removed from the scope. Program A lasted 24 months and in the end the integrated display made it into production, but there was burn out of many of the people involved in the execution teams and a lack of trust between the divisions. A second program was chartered to resolve the technical problems with the hardware and allow the development of the remaining software with the many new team members. The new team leveraged many lessons learned from Program A and the program progressed much smoother. The more complete product was delivered to customers 24 months later on the next model vehicle.

## 4.2 Program B

Program B was chartered by Division A to develop replacement hardware for a current component that was purchased from a third party and utilized in the product line

designed by Division C. Upon learning that the NewCo was working to replace the hardware and would no longer be purchasing it, the third party supplier indicated that they no longer wanted to support the web interface and backend database for the product either. This change dramatically increased the program scope, but the schedule for production launch remained the same to support the needs of Division C. This change in scope also moved into a very new technical area where NewCo lacked experience and expertise. Management added significant resources from the IT Division to close the gap. This marked the first major customer facing product the IT Divisions was involved with and their lack of experience with the product design process proved a challenge throughout the program.

Well into the program additional scope creep occurred when a major customer feature was added to encourage additional product lines (AA, CC, and DD) to integrate the subsystem in their vehicles. As additional product lines became involved the stakeholders for the Program Blossomed to an unmanageable size with many conflicting requirements. The large scope of Program B exceeded the complexity of any program that had been managed to date and chartered new territory for NewCo. No single individual could understand the full breadth of the subsystem requiring many different groups to work on individual segments.

Program B was centrally planned by Division A. About a year into the program Division A began to proactively manage the large group of stakeholders with a formal communications plan. There was a high level council that meet monthly to receive program updates and the working teams meet on a weekly basis to share information and progress. Over the duration of the program across all the divisions involved approximately $25 million in total resources were consumed.

The product did make it into production on schedule 28 months after charter and the initial scope of replacement hardware was very successful. The program expansion to include the web interface and backend database required additional updates after initial launch to fully satisfy customer expectations. The second expansion to include an additional feature was not fully functional until a year after production launch. Considering the circumstances many consider Program B to be a success, but others that had planned upon the full scope at launch would argue that it was not.

## 4.3 Program C

Program C churned for two years before being officially chartered and is currently in development. The slow start of the program was caused by shifting expectations regarding the purpose of the product, the appropriate scope, and the correct product strategy. Program C again had many internal stakeholders with conflicting customer needs, cost targets, and vehicle schedules. Many of the team members from programs A and B have been involved in Program C and are trying to leverage the lessons learned from those earlier programs. This has increased the emphasis and understanding of the importance of stakeholder involvement and open communications.

Program C is being executed using an iterative software development process instead of the waterfall approach used on previous programs. A new shared engineering services organization was created in a recent reorganization and that group is conducting the centralized planning. The shared engineering services group is allocating requirements to Division A to execute. Program C is so large that within Division A the scope is being further decomposed so that three management teams are responsible for the three major feature sets within the application software.

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# Chapter 5

## STAKEHOLDER ANALYSIS

NewCo as a whole has many stakeholders. "A stakeholder is any group or individual who can affect or is affected by the achievements of the organization's objective." (Freeman 1984) For large complex enterprises there are multiple stakeholders related to many aspects of the business. It is critical that an enterprise balance the needs of all stakeholders to be successful. This research has focused on the stakeholders that contribute to the new product development value chain within Division A. Figure 8 identifies the seven broad stakeholder categories effecting Division A's new product development. The following section discusses each stakeholder group.


*Figure 8. Stakeholders of Division A*

## 5.1 Employees

The employees group includes all levels of management as well as union members. The employees desire competitive compensation, rewarding work and other tangible and intangible items. In exchange the employees contribute effort and knowledge to the enterprises value creation.

## 5.2 NewCo Leadership

The NewCo corporate leadership is vested in the financial performance of each division. NewCo provides strategic guidance, allocates budget, and approves major capital investments. The NewCo leadership group includes the president and vice presidents from each of the major divisions as well as the board of directors.

## 5.3 Shareholders

Due to the emphasis on financial performance from NewCo leadership each division is working to generate value for the shareholders in return for their invested capital. It could be argued that the shareholders are a stakeholder for the NewCo leadership and the NewCo leadership is the primary stakeholder for the division, but with the heavy emphasis placed on delivering shareholder value the shareholders have been included at the division level as well for this analysis.

## 5.4 Customers and Distribution Channel

Customers and distribution channel are directly tied to the division when developing customer facing aftermarket products and at other times translated through internal partners when being delivered as subsystems within the vehicle product lines. The needs of these two groups are distinct, but they related to the finished products and services that the Division A and NewCo delivers.

## 5.5 External Partners

External partners have many different relationships with the division, but they are clearly defined, often contractually. This group includes part suppliers, contract engineering houses, test facilities, and joint ventures. External partners are becoming increasingly

important as globalization shrinks the world in which we are working and provides opportunities to improve the value delivered to stakeholders.

## 5.6 Internal Partners

The internal partners that Division A interacts with heavily are shown in Figure 9. Each of these groupings has unique aspects that drive much of the complexity in stakeholder management. Each grouping is briefly described in the following section.


***Figure 9. Internal Partners that Interact with Division A***

### *5.6.1 Division C*

Division C is a completely independent group that includes marketing, engineering, and manufacturing organizations to support a unique market segment and a major set of

product lines. Division C has unique needs based upon their current competitive position in their market segment. They are much more risk tolerant than the product lines within Division B.

### 5.6.2 *Division B Marketing Regions*

Division B includes major marketing regions covering the global footprint of NewCo. The marketing organization is currently undergoing a major transformation to improve the primary process by which they gather customer information and product opportunities and feed that information into the product development process. Historically NewCo had relied upon the background of its engineering organization to understand and drive the necessary product developments while the marketing organization focused on sales and distribution. With the global expansion of NewCo and less industry background within the current talent pool of engineers it has become critical that the marketing organization take ownership of gathering customer needs and product opportunities. The transition will be difficult as it requires the marketing organization to develop a new competency as well as a new relationship with their engineering counterparts. There are many members of both the engineering and marketing leadership that were successful in the former paradigm and could resist the change.

### 5.6.3 *Division B Product Lines*

The next grouping includes a dichotomy with two segments. It includes the five major product line groupings of Division B as well as the leadership from the previous product line's organizational structure. A recent reorganization attempted to consolidate influence and power into five major product line groups with the purpose of managing and aligning globally and allow faster decision making. The transition does not appear to have been fully executed as a portion of the power and influence has remained with the previous

product line leadership. This dichotomy creates additional complexity that can be dangerous as it is not transparent to those that may be working with the various stakeholders. Historically, attempts to consolidate the engineering organization within NewCo were largely unsuccessful.

### *5.6.4 Shared Services and Supporting Businesses*

The next grouping includes two similar segments that are often lumped together, but I believe should be distinguished from each other. Shared services and supporting businesses are a group of organizational entities that do not represent a major product line. These often are centralized services or component divisions that are leveraged by multiple product lines. There are critical differences in how each of the groups is perceived by the product lines.

A supporting business has an OEM product that they are responsible for managing. The idea of having portions of the overall enterprise involved in OEM products is that it should drive the enterprise to remain competitive in these market segments. Therefore the supporting businesses place a high priority on innovation. The downside is that when a decision must be made between the OEM customers and the internal product line customers it is difficult to decide which should be given priority. Due to this difficult position the product lines perceive that the OEM business is at times prioritized ahead of them and that the supporting business is biased towards their own external customers. This creates doubt and a barrier to trust that is difficult for the supporting businesses to overcome even if they prioritize the internal product lines. One interviewee described it as an "identity crisis" that complicates decision making from the highest levels of management in the supporting business down to the day to day activities of each individual. Divisions A, D, and E have been considered supporting businesses for the purposes of this research.

A shared service, on the other hand, is considered neutral by the product lines. They have no external customers of their own and are perceived to be fair when balancing between the various internal customers (product lines). The shared services place emphasis on meeting the product lines' requests to their desired schedule. There is less room for or time allocated towards innovation. Many examples of successful shared services can be identified within the enterprise including business development, supply management, quality, and parts.

### *5.6.5 Councils*

The final grouping includes the many councils and committees that have been formed to span the organizational structure, drive alignment, and resolve conflict. However, evidence gathered indicates that many of these are ineffective as they have limited or no authority over the final decisions of the product lines. In practice the councils serve as information sharing forums that can add complexity to stakeholder relationships. These councils merely treat the symptoms, and do nothing to address the root cause, which is an organizational structure that is not supporting the needs of the stakeholders.

## 5.7 Stakeholder Prioritization

Stakeholder saliency is defined as "the degree to which the enterprise gives priority to different stakeholder needs"(Mitchell, Agle et al. 1997). Saliency is assessed by considering three key attributes also defined by Mitchell, Agle et al. (1997) and also discussed by Nightingale and Srinivasan (2011):

1. Power: The stakeholder can utilize coercive, utilitarian, or symbolic means to influence the enterprise.
2. Legitimacy: It is perceived that the stakeholder actions are desirable, proper, or appropriate within some socially constructed system of norms, values,

beliefs, and definitions. When legitimacy is combined with power it creates authority.

3. Urgency: Exists when the relationship is either time sensitive or of importance to the stakeholder's strategy and operations.

Each of the stakeholder groups was evaluated from the perspective of Division A with the results shown in Figure 10. Customers were placed on the line of power due to an inconsistency in exhibiting the trait.

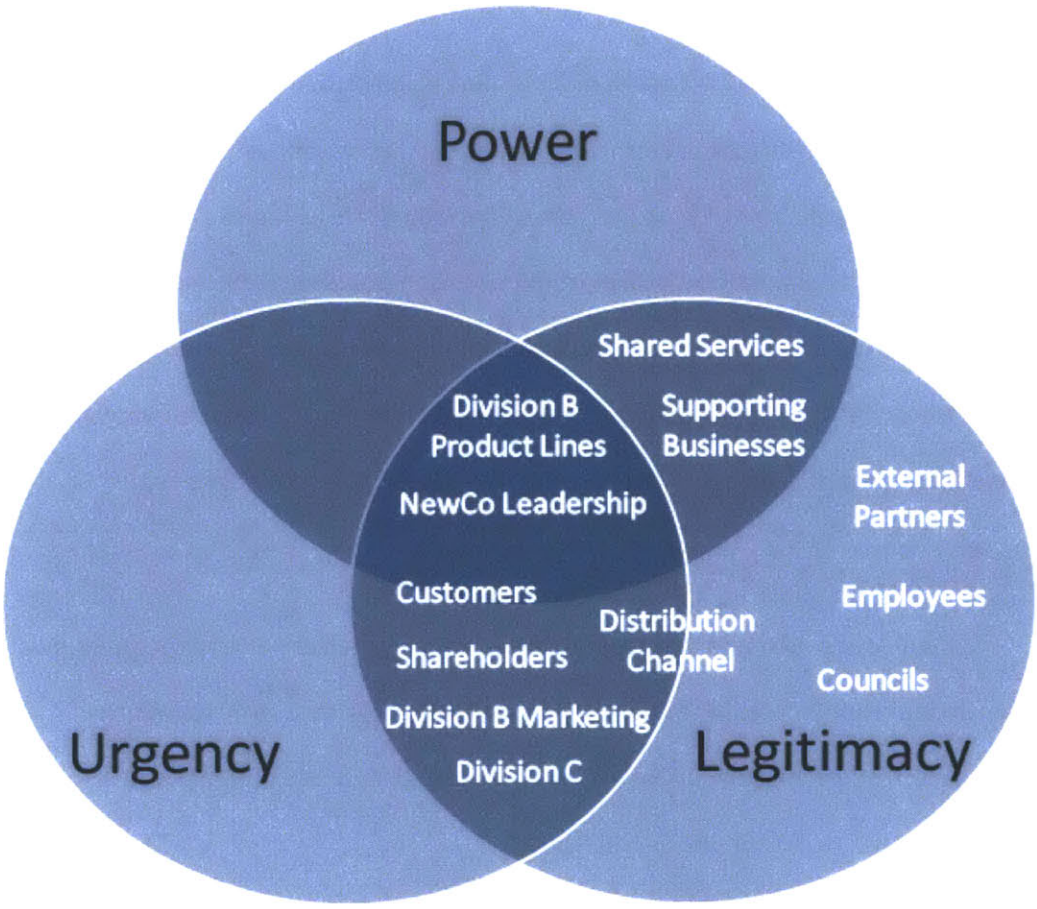


*Figure 10. Venn Diagram of Stakeholder Saliency*

The stakeholder saliency Venn diagram (Figure 10) can then translate to stakeholder priority. Stakeholders exhibiting all three traits are considered dominant and their needs must be met by the division. Stakeholders with two traits are expectant and their needs should be met by Division A. Finally stakeholders exhibiting a single trait are a latent stakeholder whose needs could be met. They should not be ignored, but are not as critical to the success of enterprise as the dominant and expectant stakeholders. Figure 11 shows the topology of stakeholders developed by Mitchell, Agle et al. (1997).

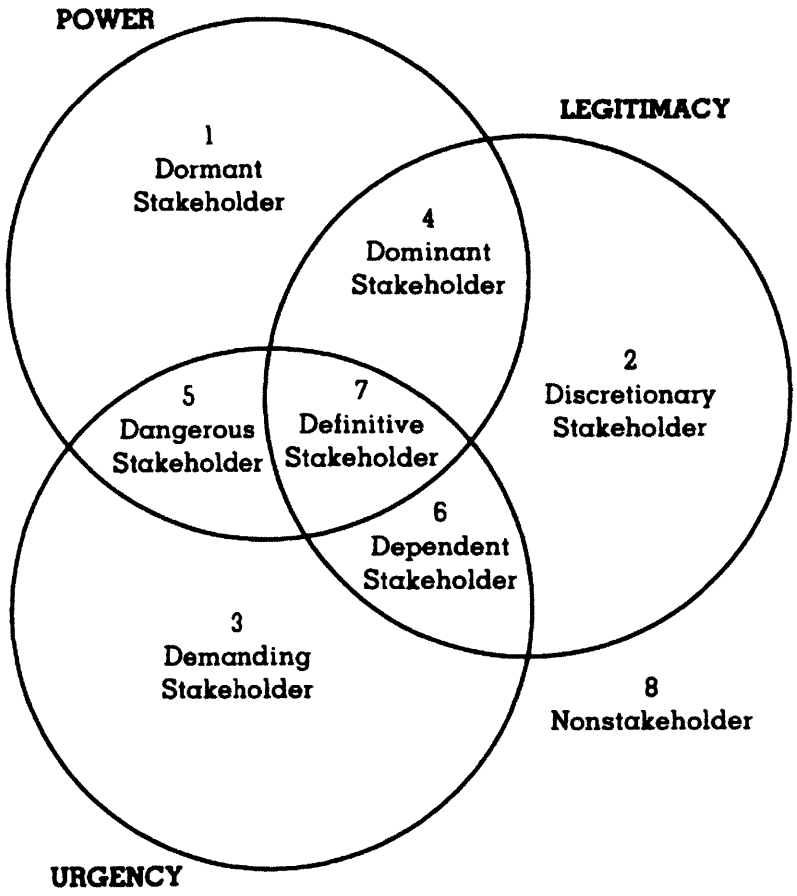


*Figure 11. Stakeholder Topology (Mitchell, Agle et al. 1997)*

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# Chapter 6

## CURRENT STATE EVALUATION

The current state of NewCo and Division A were evaluated using the Eight Views Framework discussed in the literature review. The eight views capture a complete picture of entire enterprise from a range of perspectives. Viewing the enterprise through these eight views can identify the interdependencies between the views. Each of the eight lenses or perspectives, shown in Figure 12, as well as the interactions between each lens is discussed in the following sections.

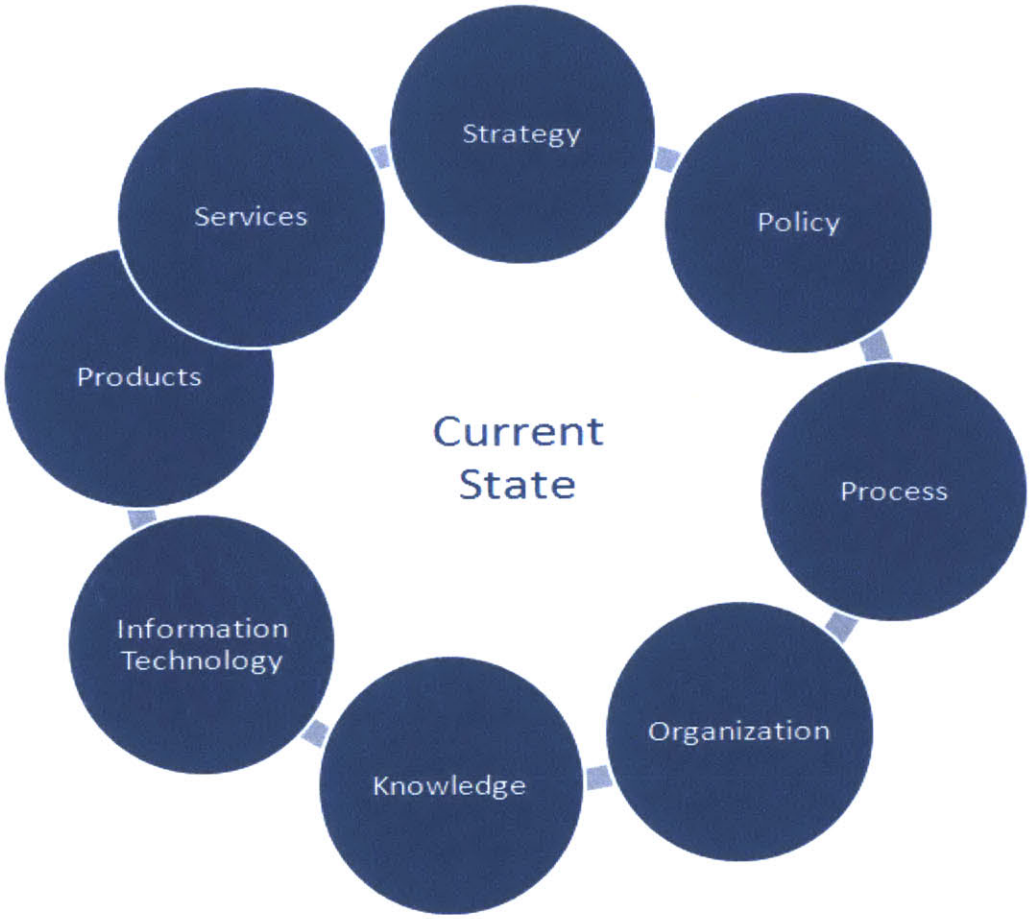



*Figure 12. Eight Views Framework*

## 6.1 Products and Services

As discussed in the motivation section, shifting customer expectations are pushing products to become more intuitive to use and provide a similar user experience product to product. This combined with the business's desire to leverage platforms and common components to increase profit margins and speed to market create an urgency for the enterprise to evolve and stay competitive. Heavy research and development investments in new technologies create a strong incentive for commonality. At the same time the products

and services are becoming more tightly integrated into a larger system of systems due to the increasing capabilities of technology.

The shift towards a system of systems is paired with increased reliance upon software; this ranges from embedded controllers to interconnected communication networks. The development cadence for software and electronic hardware is much faster than that of the traditional product lines. Iterative software development also offers the opportunity to consider incremental delivery versus a model year based approach typical of vehicle product lines.

Changes occurring in the products and services view affect the other lenses as well. Is the strategy aligned to support a system of systems and the new customer expectations? Can the policy and organization adjust to support products that are part of a system of systems rather than optimize an individual product line? How will knowledge of the system of systems interactions be managed? Do the processes support a system of systems and increased importance of software? How can information technology enable the identified changes? The effect of the changes seen in products and services is considered as each lens is discussed in the following sections.

## 6.2 Strategy

The number one key topic identified in the interview process was difficulty aligning around a vision or strategy, a lack of overall priority, or a lack of clear common goals. This finding was consistent regardless of organizational division, functional background, or leadership level. When interviewees were asked what the strategy was for their division, many different responses were gathered. In some cases members of the same organizational silo had different responses, indicating a lack of alignment. The lack of a

common strategy was also discussed during interviews as one of the key factors contributing towards difficult decision making.

One suggestion would be to align the enterprise around Big Hairy Audacious Goals (BHAGs, pronounced bee-hags). BHAGs, first introduced by Collins and Porras (2004), have been referenced in literature on enterprise strategy and transformation. A BHAG is described as a clear and compelling goal to motivate the organization even through a change in leadership. A BHAG should be difficult to achieve and should stretch the enterprise. Additional BHAGs should be pursued once the initial BHAGs are achieved. This will prevent a plateau in progress. To be effective a BHAG should be consistent with the core ideology of the company.

If the NewCo were to identify one or more BHAGs and clearly articulate it through the divisions, then this shared strategy could form a solid foundation for decision making and prioritization across the divisions. NewCo's current strategy, as articulated in company documents, outlines a purpose, specifically the need for global growth and increasing shareholder value. However, the purpose does not create a clear achievable goal. The vagueness allows individual interpretation by each vice president and director about the best means to achieve the growth goal and adds conflict and tension rather than unifying the organization.

Evidence gathered shows the lack of consistent strategy across the enterprise can be partially attributed to the depth that decentralization and independent thinking permeates the culture. Throughout NewCo's history there has been periodic discussions regarding the degree of decentralization that is appropriate. Company documentation notes that in the 1920's the CEO was unable to make the factories share development efforts. In 1950's consultants reported to NewCo's CEO that they were concerned with the degree of

decentralization commenting, "executives in the company had an overly simplistic view, confusing decentralization with almost complete autonomy." Again in the 1970's a companywide memo discusses the creation of a new enterprise wide product engineering council and product engineering technical committee as a "means for corporate coordination" and "organized communication." The same memo includes a conflicting statement that product engineering strategy would remain the responsibility of each factory general manager. Four interviewees identified that a "fundamental change is needed from [business] unit independence to an [overall] enterprise focus" reiterating that the longstanding tension between centralization and decentralization remains strong today,

The analysis uncovered a key strategy question: is the product and services evolution really becoming a system of systems? NewCo has a strategic choice. They can continue with loosely coordinated, decentralized product lines that integrate their products and services into a system of systems. However, NewCo is in a unique position and has a second option. Using Maier's characteristics of a system of systems the constituent systems should be controlled by independent authorities. NewCo has the ability to develop a very large, very complex monolithic design, if they choose to centrally manage the design. The monolithic design allows for additional systems architecting and systems engineering tools to be leveraged during the development and reduces the reliance upon communication standards. This also provides NewCo an advantage over other competitors that do not have as broad of a product line offering.

When looking specifically at the strategy within Division A one interviewee explained the situation well, "we are in the midst of an identity crisis." As a supporting business Division A is torn between delivering innovative products to the customers and supporting the product lines. At any given time the priority between the roles is undefined.

This lack of definition leaves everyone in the division from the director to the program manager to the engineer to debate with themselves which effort she should be focused on. Various methods of allocating resources between each role have been tried in recent history, but none have been able to remove the uncertainty surrounding the current priorities.

As mentioned earlier, when discussing the differences between shared services and supporting business, there is a tension with internal partners where the partners perceive that they are not being given the appropriate priority and resource allocation by Division A and E. The concern over priority from internal partners has escalated in the past few years as the culture has begun to shift and the vehicle product lines see benefit in the additional features provided by the subsystems and components designed by Division A. Some of the subsystems and components have been incorporated in the vehicles direct from the factory. Previously the subsystems were all designed to be purchased and installed aftermarket by customers who saw value in the solutions provided. This allowed the business to focus on innovative solutions that would create OEM business.

## 6.3 Policy

Research conducted found that the current enterprise policies reinforce local optimization of each product line. The profitability metric was mentioned by 20% of interviewees as a hurdle when working towards commonality while the allocation of research and development dollars was brought up by 17% of interviewees. Both of these policies have been instrumental in the success of the business to this point, but should be reviewed and possibly revised or balanced with a new metric to support the changing customer expectations.

The profitability metric creates cost sensitivity to the part prices. This often prevents a common component with features to support the needs of a broad customer set to be utilized across a range of product lines. Each product line optimizes the component cost by including only the features their application requires. The literature review discussed the current research on how to best evaluate the pros and cons of investing in platforms. A key takeaway was that the platforms needed to be strategically managed and not left to the whims of the product lines.

The allocation of research and development dollars, particularly when working with internal partners to develop platforms, currently does easily not allow product lines to "share" the investment. The result is that the largest product lines, which can support the investment, optimize the components to fit their specific needs. This is because the largest product lines provide the majority of the funding. The needs of other portions of the organization are considered only if they do not dramatically impact the part cost, research and development cost, or program schedule.

Policies have significant impact on decision making that can be further understood by looking at the principal-agent model. The model applies when one party, the principal, delegates a task, to another party, the agent. Two key points of incentive theory is an asymmetry of information and conflicting objectives between the parties. (Laffont and Martimort 2002) Incentives, or in this specific situation metrics, are used to align the objectives of the various parties. (Laffont and Martimort 2002) The asymmetry of information has two primary causes, hidden action and hidden knowledge. If the asymmetry of information did not exist and the information was common knowledge then the best decisions would be reached. However, there is a tradeoff between distributing the

information and efficiency in decision making. This is frequently referred to as agency cost and what prevents the perfect distribution of information.

There is an extension of the principal-agent model that adds the impact of risk sharing between the principal and the agent. This is often an issue when there are different levels of risk tolerance between the principal and agent or between agents. Outcome oriented metrics transfer risk from the principal to the agent and may impact decision making. (Eisenhardt 1989) Research found there was a significantly different risk tolerance level between the product lines. When reviewing the interviews from the different divisions of NewCo, it was evident that each division felt it was doing what it believed to be best, but when viewing the situations from a broader perspective with additional information some of the decisions were not the best possible for the enterprise.

Meyer et al. (1997) discuss how common research and development metrics are not suitable when working with product families and investing in platform based development. They discuss how new platform development is much more risky, technically speaking, than developing evolutionary products that leverage or extend the platform, but that the investment in the new platforms prevents obsolescence and avoids potential market risks. Meyer et al. proposed two measures, platform efficiency and platform effectiveness. Platform efficiency is the ability of the platform to provide an economical starting point and be leveraged in new products. Platform effectiveness is the ability of the products leveraging the platform to generate a return relative to the cost of development. An excellent quote to reinforce the importance of investing in platforms:

> *How can we get management to understand the difference between platform efforts and those for specific products? Our new product planning processes focus on single products, and the emphasis is to create them faster and at*

*lesser cost. We can't achieve this without newer and better platforms. Too often, our efforts to renew aging platforms are pursued 'undercover', and we start them too late. We need our planning processes and reward systems to facilitate and encourage appropriate behavior with respect to platform development and renewal.- Senior Engineer (Meyer, Tertzakian et al. 1997)*

Hoskisson et al. (1993) found that emphasis on division financial incentives is negatively related to research and development (R&D) intensity. R&D intensity represents risk aversion and is calculated by the R&D expense divided by the net sales revenue. This emphasis on financial incentives may lead to greater managerial risk aversion as projects are no longer measured on strategic attractiveness.

Hauser (1998) discusses how effective metrics should vary by the tier of research, development, and engineering. Tier one represents basic research, tier two builds technical competencies, and tier three is applied engineering as shown in Figure 13. Hauser suggests that firms use subsidies for tier three programs to compensate for managers picking programs that are less risky, have quicker payoffs, and are more concentrated in a single portion of the business. The subsidies should be larger for the programs with higher risk, longer payback periods, and more distributed organizational involvement. For tier two programs less emphasis on market outcome based metrics is suggested with more placed upon effort-indicating metrics. Metrics should also guard against incentive systems that create a "not invented here" culture. The NIH culture can prevent ideas from spreading across organizational boundaries.

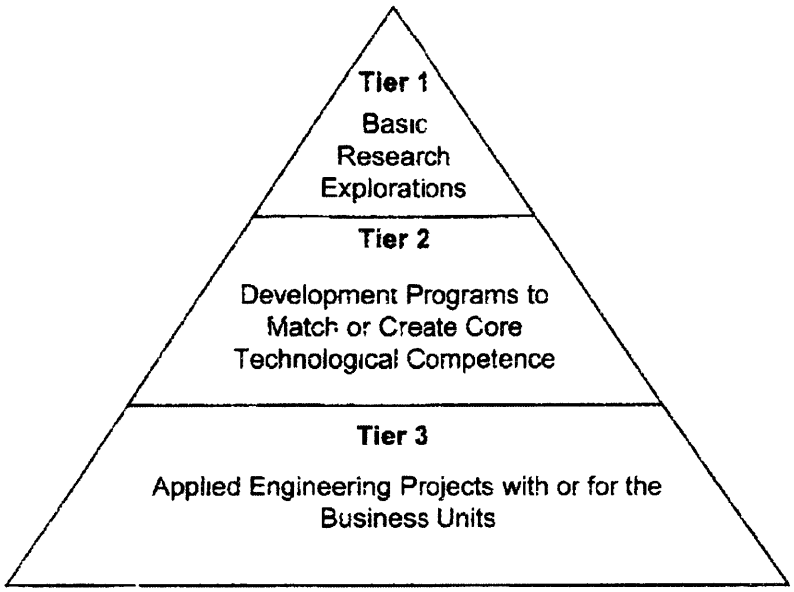



*Figure 13. Tier Definitions for Research, Development, and Engineering (Hauser 1998)*

Hauser and Katz (1998) discuss how a firm becomes what is measures. They identified seven pitfalls of counterproductive measures that are shown in. Losing sight of the goal may be the primary problem with the profitability metric at NewCo. With the shifting customer expectations the metric no longer aligns to the primary goal.

*Table 5. Seven Pitfalls of Counterproductive Metrics (Hauser and Katz 1998)*

| Pitfall | Method to Avoid |
|---|---|
| **Delaying Rewards** | Utilize metrics that can be measured today, but impact future outcomes. |
| **Using Risky Rewards** | Metrics should be influenced primarily by factors in the control of the managers and employees to reduce the risk they are exposing themselves to. |
| **Making Metrics Hard to Control** | Focus metrics on the customer need(s) that the design team can most directly influence. |
| **Losing Sight of the Goal** | Metrics should drive actions and decisions that not only improve the metric, but the overall desired outcome for the business. |
| **Choosing Metrics that are Precisely Wrong** | Measure what is truly important, not what is always the easiest to measure. |
| **Assuming Your Managers and Employees Have No Options** | Metrics should focus on encouraging employees to work smarter not harder. If metrics focus on working harder you will likely lose the best talent. |
| **Thinking Narrowly** | Take a holistic view and ensure you are doing the right things before working towards doing them well. |

Metrics empower managers and employees to make decisions, but they can have unintended and unanticipated side effects. Hausner and Katz (1998) also created a seven step system to define good metrics. This is shown in Table 6. Step one established the voice of the customer while step two establishes the voice of the employee. During step three the interrelationships between the needs gathered must be evaluated and understood. This ensures that all of the stakeholders are considered. Step four uses the house of quality to understand the linkages between the information gathered in steps one through three. Step five involves testing the metric system in two ways, the correlations and the manager and employee reactions. Step six reminds us to include the managers and employees in the development of metrics. The final step, seven, indicates that you should use steps one

through six creatively and remember that there are options to redesign and develop new processes rather than reinforce the current ones.

*Table 6. Seven Step System to Define Good Metrics (Hauser and Katz 1998)*

| | |
|---|---|
| **1** | Start by Listening to the Customer |
| **2** | Understand the Job |
| **3** | Understand the Interrelationships |
| **4** | Understand the Linkages |
| **5** | Test the Correlations and Test Manager and Employee Reactions |
| **6** | Involve the Managers and Employees |
| **7** | Seek New Paradigms |

## 6.4 ORGANIZATION

Three different topics related to the organization were discussed in interviews. The reorganization of Division B and the councils and committees were both mentioned earlier during the internal stakeholder discussion. A third topic regarding roles and responsibilities – particularly the relationships between internal stakeholders – was also discussed.

Division B recently underwent a major reorganization that created five primary sets of product lines. However, there is evidence that much of the autonomy remained with the former product lines structure. The incomplete transformation has resulted in a more complex stakeholder situation rather than a simpler one.

NewCo has created many councils and committees to bridge perceived gaps in the organizational structure. The councils fill a wide range of needs including information sharing, alignment, and in some cases decision making. Some of the councils have been split into strategic and tactical groups with differing levels of leadership from each division participating in each type of council. The councils are an indication of an organizational structure that is not meeting the needs of the enterprise stakeholders.

The roles and responsibilities and interfaces between the various internal stakeholders are poorly defined leading to inconsistencies, duplication, and in the worst cases gaps. Divisions A, D, and E are at times treated the same as external suppliers by the product lines. Some of the supporting businesses view this as a benefit, having clearly defined expectations for how a supplier should behave and interact, while others find this insulting and feel that there are many opportunities for synergy that are being lost. Many of the interviewees discussed a lack of transparency between divisions that can lead to a lack of trust and difficult working relationships.

Von Simson (1990) proposes a concept for a "centrally decentralized" IT organization. This concept is a hybrid that may be extended to the organization as a whole to find a balance between the benefits of centralization and decentralization. The concept includes a central organization that is responsible for the technology infrastructure while the application development remains decentralized within the independent business units. This allows the organization to maintain the responsiveness desired in the applications. If this concept were tied together with Hauser's concept of tiered research, an organizational structure with centralized platform development and decentralized application into the product lines could be achieved.

## 6.5 KNOWLEDGE

The wide variety of products produced and global customers served by NewCo results in a vast amount of knowledge to be obtained, shared, and managed. Decentralization of the organization has allowed each division to focus on their specific products or their specific distribution regions. Allowing each division to gain this detailed understanding of their customer needs has supported the optimization of each product line. The decentralization has also allowed for divergent solutions for similar customer needs.

This early divergence between product lines adds complexity when Programs A, B, and C work to provide a solution across product lines. Each product line includes requirements that align with the solutions they have successfully used in the past even if an alternative solution was viable.

Interviews and artifacts revealed very poor knowledge transfer between organizational divisions. Interviewees cited situations where information was shared but the receiving Division did not understand it. There have also been cases where divisions did not ask for information because they were unaware that it existed or that they need it. One interviewee commented that it is a case of "you don't know, what you don't know." There were also situations where the divisions were saying the same things and using the same words, but each had a unique meaning. Other situations the opposite was true where the divisions were saying different things using different words, but each actually had the same meaning.

Thomas and Maloney (2006) conducted a social network analysis and found that by instituting meetings that crossed organizational boundaries and implementing an incentive system that rewarded information sharing changed the patterns of communication. A network analysis of NewCo could be one method to identify bottlenecks in knowledge sharing and evaluate the changes over time.

## 6.6 Process

The product development process used by NewCo has well defined outcomes for each stage gate. Within the stage gate framework specific processes to achieve each outcome are not consistent across the divisions. There is a community of practice focused on standardizing the processes to create a common language and improve communications between divisions.

The largest hurdle for Division A in Programs A, B, and C was decision making. The decision making process at NewCo relies upon consensus. Interviewees commented that consensus works well in small teams, but is a challenge as the number of stakeholders grows. At the point programs are unable to reach consensus among the members the decision is elevated in the hierarchy or the organizational structure. This has limited effectiveness in programs like B and C where four different vice-presidents were involved. The consensus process in a highly decentralized organization does not support the difficult decisions needed when making platform choices.

There is an additional down side to escalating issues in that the decision is being made farther away from those with the most intimate knowledge of the situation. In this way process is very tightly tied to the knowledge view.

Many interviewees discussed the difficulty in establishing decision rights when the roles and responsibilities or interfaces between organizational silos are not well defined. This observation ties the process view very tightly with the organizational view.

Rouse and Boff (2004) identify that "decision-making processes – governance – are central in managing the flow of value". They identified two reasons why a good decision making process work. "First, the right attributes and tradeoffs are considered at the right time. Second, all stakeholders understand how decisions are made, how to influence decisions, and how final decisions emerge." They discuss the pitfalls of a poor decision making process highlighting many of the issues identified within NewCo and identify multistage decision processes as the current best practice. Consistent qualitative and quantitative analysis allows for comparisons and tradeoff discussions.

Huber and McDaniel (1986) established three guidelines for designing decision units as well as three guidelines for designing decision management systems, shown in

Table 7. These guidelines can be leveraged to determine the appropriate decision rights of each portion of the organization and develop an effective decision making culture where the process is respected and followed to achieve the best possible results for the enterprise.

***Table 7. Guidelines for Designing Decision Units and Decision Management Systems (Huber and McDaniel 1986)***

| | |
|---|---|
| **Guideline 1** | Assign decision making authority to the hierarchical level that minimizes the combined costs of lack of information about the problem situation, the organization's overall situation, and the appropriate organizational policy. |
| **Guideline 2** | Create a degree of specialization among decision-making units that is commensurate with the complexity of the decision situations encountered. |
| **Guideline 3** | If both routine and nonroutine decisions must be addressed, create and formalize a dual structure, one with rigid processes for routine decisions and the other with flexible processes for nonroutine decisions. |
| **Guideline 4** | Formally decide what to decide. |
| **Guideline 5** | Manage decisions as projects. |
| **Guideline 6** | Establish organizational reward systems that reward decision units for the quality of their decisions. |

## 6.7 Information Technology

Information technology was not discussed in detail, but it can be used to close gaps in the process and knowledge views. Nault (1998) identified the location of decision rights as a key feature in identifying the organizational design. He also discusses how improved performance can be seen by either moving the information closer to the decision maker or the decision rights closer to the information. IT systems can be one means to move the information without redesigning the organization.

# Chapter 7

## CONCLUSIONS

Using an exploratory research approach the current state of NewCo and Division A have been evaluated based on value exchange with stakeholders and an eight views enterprise architecting framework. The goal of this research was to identify factors making programs that span across multiple product lines and corporate divisions more difficult than expected. Nine individual factors that contribute toward the difficulties in these programs (discussed in Chapter 1), which consolidate into five categories identified and explained in the key findings section below. The research also intended to recommend potential changes to the design of the overall enterprise to improve the ability to execute programs spanning multiple product lines successfully. Six initial recommendations are presented below based upon the findings of this research. The final section presents areas

where further investigation could be conducted to further develop the current state and recommendations.

## 7.1 Key Findings

The findings of this research can be grouped into five main categories shown in Table 8. The first category ties to strategy and includes three topics: the lack of enterprise alignment, the impact of decentralized history and culture, and the strategic choice in addressing system of systems transition. The second category relates to the organization's structure and has three veins within it as well: the status of most recent organizational realignment, the perceptions around supporting businesses and shared services, and the increase in councils and committees. The third category discusses enterprise policies focusing on the metrics used to measure the divisions. The fourth category reviews the decision making process and the culture of consensus. The fifth and final category relates to knowledge sharing. This includes recent process improvements and shifting roles that affect the ability to effectively share knowledge.

*Table 8. Summary of Key Findings*

| | |
|---|---|
| **Strategy** | Enterprise Alignment<br>Decentralized History and Culture<br>Strategy for System of Systems |
| **Organizational Structure** | Completion of Organizational Realignment<br>Perceptions for Supporting Businesses and Shared Services<br>Councils and Committees |
| **Policy** | Alignment of Metrics to Strategy |
| **Decision Making** | Culture of Consensus |
| **Knowledge Sharing** | Continue Process Improvement and Role Realignment |

The first category includes three findings related to strategy. The decentralized history of NewCo strongly influenced the independent culture within each division and product line. The independence of each division and product line has allowed them to each individually identify how they believe they can best meet the high-level goals of the NewCo strategy. This freedom of interpretation creates very different approaches to achieve the same high-level goals. With the shift in customer expectations towards system of systems solutions that span product lines, the divergent approaches of each product line makes the programs spanning the product lines much more difficult to execute. NewCo has a strategic choice to continue to allow true complex system of systems to evolve with independent management of the constituent systems or they can take advantage of the breadth of their product lines and centralize some planning and engineering functions to proactively engineer the system of systems solutions. This will challenge the decentralized culture and should not be taken lightly, but may dramatically improve the alignment between divisions and product lines participating in cross cutting programs.

The second category of findings discusses how the current organizational structure is not meeting the needs of the internal stakeholders of NewCo. Numerous councils and committees have been formed to drive alignment and coordination where gaps are perceived. However, it does not appear that the councils are given any authority to truly influence the product lines decisions. They act more as an information sharing forum than an actual alignment tool. Evidence also found that the recent reorganization of Division B was incomplete, leaving a portion of the influence with the former product line leadership. The final finding in the area of organizational structure includes the perception of shared services as neutral entities looking out for the best interests of NewCo as a whole, and that

supporting businesses, like product lines, are concerned with their own profitability ahead of serving internal partners.

The third category found that the current enterprise policies reinforce local optimization of each product line. The profitability metric and allocation of research and development dollars were identified as hurdles when working towards commonality by many interviewees. Both of these policies have been instrumental in the success of the business to this point, but should be reviewed and possibly revised or balanced with a new metric to support the changing customer expectations. Policies also have a significant impact on decision making, the next finding.

The fourth category was that the decision making process at NewCo relies upon consensus, which works well in small teams. However programs crossing many product lines inherently include many internal stakeholders creating a significant challenge for efficient and effective decision making. It is currently difficult to establish decision rights with the roles and responsibilities or interfaces between organizational silos not well defined.

The fifth category acknowledges that knowledge sharing is difficult due to the breadth of information gathered across the organization. A shift in the role of the marketing organization and process improvements in feeding marketing information into the product design process have the potential to make a significant impact on the effectiveness of knowledge sharing. An overall awareness of the vast amounts of tacit knowledge within each division and proactively sharing that knowledge will prove beneficial to programs involving multiple product lines.

## 7.2 RECOMMENDATIONS

Table 9 shows six initial recommendations to improve the ability to execute programs spanning multiple product lines successfully. The first five recommendations aim to address each main category of findings presented above. The final recommendation includes reiterating that programs spanning product lines are difficult; they have their own unique challenges and should not be underestimated. The next step is to validate these recommendations with senior leaders within NewCo and determine if any will be implemented.

***Table 9. Summary of Recommendations***

| | |
|---|---|
| **1** | Intentionally "design" the system of systems solution including centralizing a portion of engineering to allocate requirements to product lines and shared services |
| **2** | Reinvigorate reorganization effort of Division B and expand shared services |
| **3** | Revise policies to incent cooperation and supporting system of systems solutions |
| **4** | Establish clear roles and empower decision makers |
| **5** | Continue to invest in process improvements within the marketing organization and the knowledge transfer into product development. |
| **6** | Increase *awareness* that commonality and system of systems solutions are *not easy* to develop and should be viewed as an investment. |

The first recommendation is that NewCo should leverage the diverse product lines and unique opportunity to "design" the system of systems solution. The initial design effort will reduce integration efforts typical of true independently managed system of systems. In order to facilitate this early design a portion of engineering should be centralized as a shared service and allocate the appropriate requirements to the product lines and other shared services to support meeting the overall customer needs. This will remove some

freedom and independence from the current decentralized divisions, but would further align the strategic direction of NewCo as a whole. A principle to apply from Maier and Rechtin (2009) would be to "think of architecture as the technical embodiment of strategy." Malan and Bredemeyer (2002) discuss a concept of "minimalist architecture" and stress the importance of maintaining system integrity and addressing cross cutting system properties while not imposing unnecessary and potentially costly constraints further down in the system.

The second recommendation has two parts. First is to complete the reorganization effort within Division B. Second is to investigate dividing the current supporting businesses into a product line to generate revenue and a shared service to support the product lines. The shared services groups would also need clear roles and decision making authority within their domain expertise. This expanded shared services network will better enable the execution of large platform investments needed to support system of systems solutions. An additional component of this reorganization could include evaluating the current councils and determining the initial alignment concern each was trying to resolve. Then allocate those roles to the appropriate shared services group. This has the potential to dramatically reduce the number of councils.

The third recommendation is to revise the current policies to encourage cooperation in support of the system of systems strategy. One suggestion would be to revise how platform development efforts conducted by shared services are budgeted and measured. The product lines could continue to focus on cost effective with current metrics with a single additional metric providing a credit for leveraging the shared service platforms. This would strongly encourage cooperation and commonality that is desired by many.

The fourth recommendation involves reinforcing the role and authority of each shared service group or product line. Empowering the portion of the organization that has the best knowledge should lead to efficient and effective decision making. Decision making can begin by gathering information from the stakeholders involved, but in the end there is a single person or very small number of people having authority to make the final decision.

The fifth recommendation is to support the current transformation effort in process within the marketing organization. This shift in role and the associated process improvements to information gathering and consolidation can significantly improve the ability to effectively share knowledge.

The final recommendation would be to reiterate that programs spanning multiple product lines are difficult. This would create awareness that commonality and system of systems solutions are not easy to develop. They should be viewed as a platform and an investment. If team members and leadership begin these programs acknowledging the challenges ahead of them they will be better able to position the program for success.

## 7.3 Areas for Further Investigation

A logical next step for this research would be to continue though the Enterprise Strategic Analysis and Transformation (ESAT) framework discussed in the literature review and complete steps five through eight for NewCo and Division A. The current state information gathered through this research could be utilized to develop a desired future state of the enterprise and from there a transformation plan to achieve the future state. In addition a follow up survey could be completed for Program C a year later to determine if the challenges for programs spanning product lines have evolved.

Another opportunity would be to conduct a larger study incorporating different enterprises within different industries that are facing the same challenge of shifting from

individual product lines to delivering customers complete integrated solutions that span traditional product boundaries. This type of research could potentially identify best practices and provide insights for the most effective enterprise architecture.

# APPENDIX A: INTERVIEW TEMPLATE

## *INTRODUCTORY MATERIAL*

**MIT Thesis Research**

**Key Issue Being Investigated**

How can we more effectively execute
programs involving multiple units
within the context of a NewCo strategy
to provide complete customer "solutions"?

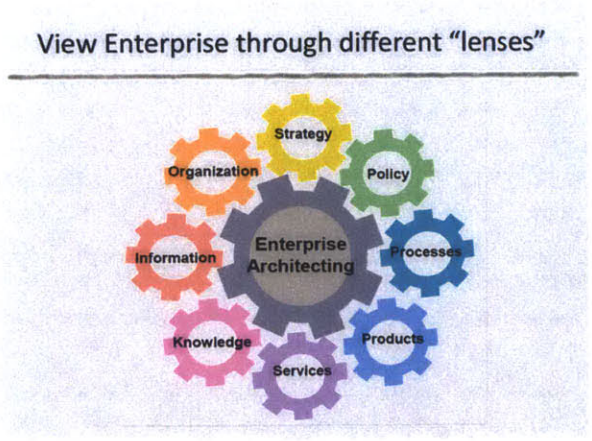
How does the current enterprise
structure/behavior/culture contribute to
the effectiveness of multi-unit programs?

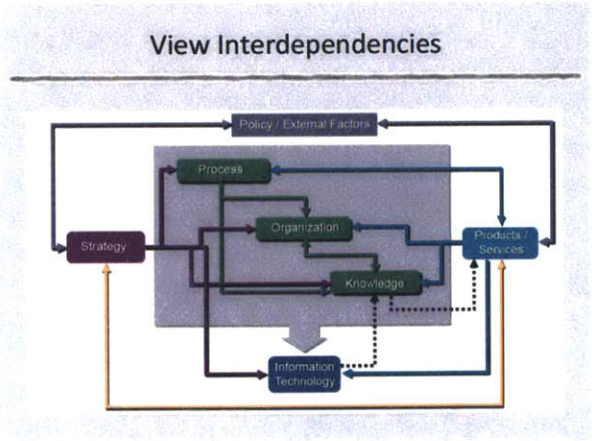
## *BACKGROUND QUESTIONS*

1. What projects have you worked on involving multiple (3+) divisions?
2. How would you describe your role on the project or involvement with the project?
3. Would you consider each project successful?
4. What went well related to the project?
5. Were there any best practices you have identified?

6. What was most difficult about the project?
7. Were there any barriers to collaboration?
8. If not a member of Division A: How would you explain your relationship and interactions with Division A?
9. Is the current approach to multi-division projects meeting your needs? If not how is it falling short?

## *Introduction of EA Approach*




Graphics from (Nightingale and Rhodes 2011)

*EIGHT VIEWS QUESTIONS*

10. How do you feel the project aligned with your division's strategy? Briefly describe your current division strategy.
11. How do you feel the project aligned with the overall enterprise strategy of "providing complete customer solutions"?
12. Can you describe any policies specific to multi- division projects that impacted your program?
13. Were there exogenous (external) factors that impacted your program?
14. How did the processes enable or impede your multi-division projects?
15. Were you able to work within the process framework to successfully execute your multi- division programs?
16. Did you use workarounds?
17. How did the organizational structure enable or impede multi-division projects?
18. How would you characterize the communications between divisions?
19. How was knowledge managed or shared between the divisions?
20. Do you feel each division had the appropriate knowledge when making decisions?
21. How were difficult decisions arbitrated?
22. Did processes, organizational structure, or knowledge sharing support or impede arbitration?
23. What characteristics of multi-division programs are important to you?

24. What would a successful structure/culture look like if you could put yourself at a future point where NewCo has addressed the challenges of multi-division programs?
25. What behaviors would be typical of a successful project if you could put yourself at a future point where NewCo has addressed the challenges of multi-division programs?

# APPENDIX B: INTERVIEW PROTOCOL

1. Give Interviewee Contact Information for Follow-up Questions
2. Provide Overview of Research Topic
3. Explain Proposed Process
    a. I will be taking notes during the interview to document your responses.
    b. After the interview I will transcribe my notes into a summary capturing the key issues we discussed.
    c. I will email you the transcribed summary for your approval and feedback.
4. Request Permission to Record Audio
5. Advise that Participation is Voluntary
    a. You may decline to answer any or all questions, if you choose.
    b. Confidentiality will be maintained unless otherwise requested and granted.
6. Complete Background Questions
7. Provide Overview of Enterprise Architecting Approach
8. Complete Questions

# APPENDIX C: INTERVIEW ANALYSIS

| Key Topic | Frequency of Occurrence | % of Interviewees |
|---|---|---|
| Difficulty aligning around a vision or strategy, Lack overall priority, Lack clear common goals | 24 | **69%** |
| Difficulty establishing common expectations | 21 | **60%** |
| Lack of established decision rights | 18 | **51%** |
| Different strategy between software and hardware | 16 | **46%** |
| Poor knowledge transfer | 13 | **37%** |
| Difficulty gathering and understanding customer needs | 11 | **31%** |
| Slow decision making due to culture of consensus and lack of hierarchy | 10 | **29%** |
| Supplier versus a partner relationship between internal divisions | 10 | **29%** |
| Desire for commonality where possible | 10 | **29%** |
| Platform stakeholders often have conflicting requirements | 10 | **29%** |
| Pace of technology in electronics mismatched with vehicles | 8 | 23% |
| Transparency in communications | 8 | 23% |
| Product line metric driving behavior and focus at local level | 7 | 20% |
| Shift in perception to Division A products being integral to vehicles versus an add on | 6 | 17% |
| Differences in risk tolerance between internal stakeholders | 6 | 17% |
| R&D cost distribution driving behavior and focus at local level | 6 | 17% |
| Customer expectations are changing quickly due to consumer products | 6 | 17% |
| Enterprise product development process defines outcomes, has a local implementation of processes | 6 | 17% |
| Difficulty gaining engagement from all internal stakeholders at program initiation | 6 | 17% |
| Internal stakeholders saying the same thing, but intending different meanings or vice versa | 5 | 14% |
| Fixed schedules often compromise the integrity of product | 5 | 14% |
| Shift to agile software development has removed visibility and responsiveness | 4 | 11% |
| Fundamental change needed from product line independence to enterprise focus | 4 | 11% |
| People are key to the success of programs | 4 | 11% |
| As an enterprise we are still learning about many new technologies | 3 | 9% |
| Competition occurs between product lines for resources | 3 | 9% |
| Scope increases during programs without resource or schedule changes | 3 | 9% |
| Struggle with partnering (buy versus build) decisions | 2 | 6% |
| Difference in enterprise led versus supporting business led efforts | 2 | 6% |
| Focus and priority should be based solely upon customers needs | 2 | 6% |
| Must control work in process and only accept new work when resources can support it | 2 | 6% |
| Key resources, often to close a knowledge gap, are not available | 2 | 6% |
| R&A metric calculation driving behavior and focus at local level | 1 | 3% |
| Revitalize recent reorganization effort | 1 | 3% |
| Products should be scalable to fit cost constraints | 1 | 3% |
| Better define role of a supporting business | 1 | 3% |
| Lack of models to analytically validate systems | 1 | 3% |
| Shift to flexible, upgradeable, and replaceable electronics architecture | 1 | 3% |
| Need the ability to work within and manage an ecosystem of development groups | 1 | 3% |
| Stakeholders must be integral to the design team and have ownership and accountability | 1 | 3% |
| Poor communication inside of Division A leads to poor communication outside Division A | 1 | 3% |
| Misunderstand the criticality of testing software on actual hardware in the use environment | 1 | 3% |

| Key Topic | % of Engineering | % of Program Management | % Difference |
|---|---|---|---|
| Difficulty aligning around a vision or strategy, Lack overall priority, Lack clear common goals | 76% | 57% | 29% |
| Difficulty establishing common expectations | 48% | 79% | 49% |
| Lack of established decision rights | **38%** | **71%** | **61%** |
| Different strategy between software and hardware | 52% | 36% | 38% |
| Poor knowledge transfer | **48%** | **21%** | **76%** |
| Difficulty gathering and understanding customer needs | 29% | 36% | 22% |
| Slow decision making due to culture of consensus and lack of hierarchy | 29% | 29% | 0% |
| Supplier versus a partner relationship between internal divisions | **38%** | **14%** | **91%** |
| Desire for commonality where possible | 29% | 29% | 0% |
| Platform stakeholders often have conflicting requirements | 24% | 36% | 40% |
| | | | |
| Pace of technology in electronics mismatched with vehicles | 29% | 14% | 67% |
| Transparency in communications | 29% | 14% | 67% |
| Product line metric driving behavior and focus at local level | **33%** | **0%** | **200%** |
| Shift in perception to Division A products being integral to vehicles versus an add on | 19% | 14% | 29% |
| Differences in risk tolerance between internal stakeholders | 19% | 14% | 29% |
| R&D cost distribution driving behavior and focus at local level | 19% | 14% | 29% |
| Customer expectations are changing quickly due to consumer products | **24%** | **7%** | **108%** |
| Enterprise product development process defines outcomes, has a local implementation of processes | 14% | 21% | 40% |
| Difficulty gaining engagement from all internal stakeholders at program initiation | 19% | 14% | 29% |
| Internal stakeholders saying the same thing, but intending different meanings or vice versa | 14% | 14% | 0% |
| Fixed schedules often compromise the integrity of product | **19%** | **7%** | **91%** |
| | | | |
| Shift to agile software development has removed visibility and responsiveness | 14% | 7% | 67% |
| Fundamental change needed from product line independence to enterprise focus | 19% | 0% | 200% |
| People are key to the success of programs | 14% | 7% | 67% |
| As an enterprise we are still learning about many new technologies | 10% | 7% | 29% |
| Competition occurs between product lines for resources | 10% | 7% | 29% |
| Scope increases during programs without resource or schedule changes | 14% | 0% | 200% |
| Struggle with partnering (buy versus build) decisions | 5% | 7% | 40% |
| Difference in enterprise led versus supporting business led efforts | 10% | 0% | 200% |
| Focus and priority should be based solely upon customers needs | 5% | 7% | 40% |
| Must control work in process and only accept new work when resources can support it | 5% | 7% | 40% |
| Key resources, often to close a knowledge gap, are not available | 5% | 7% | 40% |
| R&A metric calculation driving behavior and focus at local level | 5% | 0% | 200% |
| Revitalize recent reorganization effort | 5% | 0% | 200% |
| Products should be scalable to fit cost constraints | 0% | 7% | 200% |
| Better define role of a supporting business | 0% | 7% | 200% |
| Lack of models to analytically validate systems | 5% | 0% | 200% |
| Shift to flexible, upgradeable, and replaceable electronics architecture | 5% | 0% | 200% |
| Need the ability to work within and manage an ecosystem of development groups | 5% | 0% | 200% |
| Stakeholders must be integral to the design team and have ownership and accountability | 5% | 0% | 200% |
| Poor communication inside of Division A leads to poor communication outside Division A | 5% | 0% | 200% |
| Misunderstand the criticality of testing software on actual hardware in the use environment | 5% | 0% | 200% |

| Key Topic | % of Leadership | % of Execution | % Difference |
|---|---|---|---|
| Difficulty aligning around a vision or strategy, Lack overall priority, Lack clear common goals | 56% | 79% | 34% |
| Difficulty establishing common expectations | 56% | 63% | 12% |
| Lack of established decision rights | 44% | 58% | 28% |
| Different strategy between software and hardware | 50% | 42% | 17% |
| Poor knowledge transfer | **50%** | **26%** | **62%** |
| Difficulty gathering and understanding customer needs | 38% | 26% | 35% |
| Slow decision making due to culture of consensus and lack of hierarchy | 31% | 26% | 17% |
| Supplier versus a partner relationship between internal divisions | **19%** | **37%** | **65%** |
| Desire for commonality where possible | **50%** | **11%** | **130%** |
| Platform stakeholders often have conflicting requirements | 25% | 32% | 23% |
| | | | |
| Pace of technology in electronics mismatched with vehicles | **38%** | **11%** | **112%** |
| Transparency in communications | 25% | 21% | 17% |
| Product line metric driving behavior and focus at local level | 25% | 16% | 45% |
| Shift in perception to Division A products being integral to vehicles versus an add on | **31%** | **5%** | **142%** |
| Differences in risk tolerance between internal stakeholders | 25% | 11% | 81% |
| R&D cost distribution driving behavior and focus at local level | **31%** | **5%** | **142%** |
| Customer expectations are changing quickly due to consumer products | 19% | 16% | 17% |
| Enterprise product development process defines outcomes, has a local implementation of processes | 19% | 16% | 17% |
| Difficulty gaining engagement from all internal stakeholders at program initiation | 13% | 21% | 51% |
| Internal stakeholders saying the same thing, but intending different meanings or vice versa | 13% | 16% | 23% |
| Fixed schedules often compromise the integrity of product | **6%** | **21%** | **108%** |
| | | | |
| Shift to agile software development has removed visibility and responsiveness | 0% | 21% | 200% |
| Fundamental change needed from product line independence to enterprise focus | 13% | 11% | 17% |
| People are key to the success of programs | 19% | 5% | 112% |
| As an enterprise we are still learning about many new technologies | 13% | 5% | 81% |
| Competition occurs between product lines for resources | 6% | 11% | 51% |
| Scope increases during programs without resource or schedule changes | 6% | 11% | 51% |
| Struggle with partnering (buy versus build) decisions | 13% | 0% | 200% |
| Difference in enterprise led versus supporting business led efforts | 6% | 5% | 17% |
| Focus and priority should be based solely upon customers needs | 0% | 11% | 200% |
| Must control work in process and only accept new work when resources can support it | 0% | 11% | 200% |
| Key resources, often to close a knowledge gap, are not available | 0% | 11% | 200% |
| R&A metric calculation driving behavior and focus at local level | 6% | 0% | 200% |
| Revitalize recent reorganization effort | 6% | 0% | 200% |
| Products should be scalable to fit cost constraints | 6% | 0% | 200% |
| Better define role of a supporting business | 6% | 0% | 200% |
| Lack of models to analytically validate systems | 6% | 0% | 200% |
| Shift to flexible, upgradeable, and replaceable electronics architecture | 6% | 0% | 200% |
| Need the ability to work within and manage an ecosystem of development groups | 6% | 0% | 200% |
| Stakeholders must be integral to the design team and have ownership and accountability | 0% | 5% | 200% |
| Poor communication inside of Division A leads to poor communication outside Division A | 0% | 5% | 200% |
| Misunderstand the criticality of testing software on actual hardware in the use environment | 0% | 5% | 200% |

| Key Topic | % of Division A | % of Division E | % of Product Line AA | % of Product Line DD | % of Division C |
|---|---|---|---|---|---|
| Difficulty aligning around a vision or strategy, Lack overall priority, Lack clear common goals | 78% | 67% | 57% | 50% | 50% |
| Difficulty establishing common expectations | 56% | 83% | 71% | 0% | 50% |
| Lack of established decision rights | 50% | 67% | 71% | 0% | 0% |
| Different strategy between software and hardware | **61%** | **0%** | **43%** | **50%** | **50%** |
| Poor knowledge transfer | 39% | 17% | 57% | 0% | 50% |
| Difficulty gathering and understanding customer needs | 39% | 33% | 29% | 0% | 0% |
| Slow decision making due to culture of consensus and lack of hierarchy | **44%** | **17%** | **14%** | **0%** | **0%** |
| Supplier versus a partner relationship between internal divisions | 33% | 33% | 29% | 0% | 0% |
| Desire for commonality where possible | 17% | 33% | 29% | 100% | 50% |
| Platform stakeholders often have conflicting requirements | 22% | 33% | 43% | 0% | 50% |
| | | | | | |
| Pace of technology in electronics mismatched with vehicles | 17% | 33% | 29% | 0% | 50% |
| Transparency in communications | 22% | 17% | 43% | 0% | 0% |
| Product line metric driving behavior and focus at local level | 17% | 17% | 43% | 0% | 0% |
| Shift in perception to Division A products being integral to vehicles versus an add on | 11% | 0% | 43% | 50% | 0% |
| Differences in risk tolerance between internal stakeholders | 17% | 0% | 29% | 0% | 50% |
| R&D cost distribution driving behavior and focus at local level | 11% | 17% | 29% | 50% | 0% |
| Customer expectations are changing quickly due to consumer products | 17% | 17% | 0% | 50% | 50% |
| Enterprise product development process defines outcomes, has a local implementation of processes | 17% | 17% | 29% | 0% | 0% |
| Difficulty gaining engagement from all internal stakeholders at program initiation | 22% | 17% | 14% | 0% | 0% |
| Internal stakeholders saying the same thing, but intending different meanings or vice versa | 17% | 17% | 0% | 0% | 50% |
| Fixed schedules often compromise the integrity of product | **28%** | **0%** | **0%** | **0%** | **0%** |
| | | | | | |
| Shift to agile software development has removed visibility and responsiveness | 11% | 0% | 14% | 0% | 50% |
| Fundamental change needed from product line independence to enterprise focus | 22% | 0% | 0% | 0% | 0% |
| People are key to the success of programs | 22% | 0% | 0% | 0% | 0% |
| As an enterprise we are still learning about many new technologies | 6% | 17% | 0% | 0% | 50% |
| Competition occurs between product lines for resources | 6% | 0% | 0% | 100% | 0% |
| Scope increases during programs without resource or schedule changes | 6% | 17% | 0% | 0% | 50% |
| Struggle with partnering (buy versus build) decisions | 0% | 17% | 14% | 0% | 0% |
| Difference in enterprise led versus supporting business led efforts | 0% | 0% | 14% | 0% | 50% |
| Focus and priority should be based solely upon customers needs | 11% | 0% | 0% | 0% | 0% |
| Must control work in process and only accept new work when resources can support it | 11% | 0% | 0% | 0% | 0% |
| Key resources, often to close a knowledge gap, are not available | 11% | 0% | 0% | 0% | 0% |
| R&A metric calculation driving behavior and focus at local level | 6% | 0% | 0% | 0% | 0% |
| Revitalize recent reorganization effort | 6% | 0% | 0% | 0% | 0% |
| Products should be scalable to fit cost constraints | 0% | 17% | 0% | 0% | 0% |
| Better define role of a supporting business | 0% | 17% | 0% | 0% | 0% |
| Lack of models to analytically validate systems | 0% | 0% | 14% | 0% | 0% |
| Shift to flexible, upgradeable, and replaceable electronics architecture | 0% | 0% | 14% | 0% | 0% |
| Need the ability to work within and manage an ecosystem of development groups | 0% | 0% | 14% | 0% | 0% |
| Stakeholders must be integral to the design team and have ownership and accountability | 6% | 0% | 0% | 0% | 0% |
| Poor communication inside of Division A leads to poor communication outside Division A | 6% | 0% | 0% | 0% | 0% |
| Misunderstand the criticality of testing software on actual hardware in the use environment | 0% | 0% | 14% | 0% | 0% |

| Key Topic | % Difference A to E | % Difference A to AA, DD, & C | % Difference A to all others |
|---|---|---|---|
| Difficulty aligning around a vision or strategy, Lack overall priority, Lack clear common goals | 15% | 35% | 28% |
| Difficulty establishing common expectations | 40% | 2% | 15% |
| Lack of established decision rights | 29% | 10% | 6% |
| Different strategy between software and hardware | **200%** | 29% | 70% |
| Poor knowledge transfer | 80% | 16% | 10% |
| Difficulty gathering and understanding customer needs | 15% | 73% | 49% |
| Slow decision making due to culture of consensus and lack of hierarchy | 91% | 132% | **116%** |
| Supplier versus a partner relationship between internal divisions | 0% | 59% | 34% |
| Desire for commonality where possible | 67% | 93% | 85% |
| Platform stakeholders often have conflicting requirements | 40% | 48% | 45% |
| | | | |
| Pace of technology in electronics mismatched with vehicles | 67% | 48% | 55% |
| Transparency in communications | 29% | 20% | 6% |
| Product line metric driving behavior and focus at local level | 0% | 48% | 34% |
| Shift in perception to Division A products being integral to vehicles versus an add on | 200% | 106% | 72% |
| Differences in risk tolerance between internal stakeholders | 200% | 48% | 6% |
| R&D cost distribution driving behavior and focus at local level | 40% | 84% | 72% |
| Customer expectations are changing quickly due to consumer products | 0% | 9% | 6% |
| Enterprise product development process defines outcomes, has a local implementation of processes | 0% | 9% | 6% |
| Difficulty gaining engagement from all internal stakeholders at program initiation | 29% | 84% | 62% |
| Internal stakeholders saying the same thing, but intending different meanings or vice versa | 0% | 59% | 34% |
| Fixed schedules often compromise the integrity of product | 200% | 200% | **200%** |
| | | | |
| Shift to agile software development has removed visibility and responsiveness | 200% | 48% | 6% |
| Fundamental change needed from product line independence to enterprise focus | 200% | 200% | 200% |
| People are key to the success of programs | 200% | 200% | 200% |
| As an enterprise we are still learning about many new technologies | 100% | 48% | 72% |
| Competition occurs between product lines for resources | 200% | 106% | 72% |
| Scope increases during programs without resource or schedule changes | 100% | 48% | 72% |
| Struggle with partnering (buy versus build) decisions | 200% | 200% | 200% |
| Difference in enterprise led versus supporting business led efforts | 0% | 200% | 200% |
| Focus and priority should be based solely upon customers needs | 200% | 200% | 200% |
| Must control work in process and only accept new work when resources can support it | 200% | 200% | 200% |
| Key resources, often to close a knowledge gap, are not available | 200% | 200% | 200% |
| R&A metric calculation driving behavior and focus at local level | 200% | 200% | 200% |
| Revitalize recent reorganization effort | 200% | 200% | 200% |
| Products should be scalable to fit cost constraints | 200% | 0% | 200% |
| Better define role of a supporting business | 200% | 0% | 200% |
| Lack of models to analytically validate systems | 0% | 200% | 200% |
| Shift to flexible, upgradeable, and replaceable electronics architecture | 0% | 200% | 200% |
| Need the ability to work within and manage an ecosystem of development groups | 0% | 200% | 200% |
| Stakeholders must be integral to the design team and have ownership and accountability | 200% | 200% | 200% |
| Poor communication inside of Division A leads to poor communication outside Division A | 200% | 200% | 200% |
| Misunderstand the criticality of testing software on actual hardware in the use environment | 0% | 200% | 200% |

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